INSTRUCTION MANUAL

INSTRUMENT SOFTWARE VERSION 1.2

A sound level meter with built-in real time analyser capabilities. Parallel octave filters are standard (optional in some markets), but the impressive list of optional extensions include sound power calculations, third octave filters and statistics in every frequency band, multispectrum and reverberation time measurements. The instrument logs level vs. time (optional) and when it is equipped with multiple time constants and the enhanced profile extension, a multitude of functions is logged simultaneously. The 120 dB dynamic range eliminates the need for range setting. A large memory and high-speed data transfer rates complete our user-friendliest solution to date.

nor118
REAL TIME ANALYSER

nor**118**

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Nor118 User Guide – November 2002 Edition

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Finding the information you need

Thank you for choosing Norsonic! The Nor118 has been designed to give you many years of safe, reliable operation.

Your approach to the Nor118 documentation depends on what you want to do and how much you already know.

The *Nor118 User Guide* has been divided into eighteen chapters or sections plus index. Each chapter provides different information. Depending on your requirements and your familiarity with sound measurements as such, you may find that you use some parts of this manual often and others not at all.

The very first chapter acquaints you with the Nor118 and describes its features and possibilities. This may be a good starting point so that you know more about what to look for and what you maybe should learn more about.

The next section provides a closer look at the instrument with a presentation of all major parts and the keys of the keyboard.

Calibration is a vital point ensuring that your measurements are sufficiently correct for the purpose. Therefore, a separate chapter has been devoted to this.

How to measure with the Nor118 is described in the following chapters. The first measurement description outlines the use of the Nor118 as a simple sound level meter. The second description extends the description to also include frequency analysis. Some general information on the basic use of the instrument appears in both these chapters to avoid "page-riding". Hence, if you read both chapters you will find a repetition of certain issues.

The third of these chapters deals with the basic level vs. time extension. If you are going to make level vs. time measurements you should read the two preceding measurement description chapters first, to get a good understanding of the instrument's behaviour. The enhanced version of the level vs. time mode is described in the following chapter, but we do recommend that you read both the L(t) chapters to get a good overview.

New in this version of the instrument is the multispectrum which allows the level vs. time to log complete spectra as an f(t). This feature made it natural to include reverberation time, which has been granted its own chapter.

Sound power calculation based on sound pressure level measurements is also new in this version. Although a fairly thorough description is given, we recommend that you get yourself a copy of the applicable standard.

Note that the instruction manual describes a fully equipped instrument. Your version may not have all the optional extensions available. Extensions may, however, with a few exceptions be installed as retrofit any time.

Our objective with this manual has been to address your goals and needs. Please let us know how well we succeeded!

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nor118

REAL TIME ANALYSER

Introducing the sound level meter Nor118

An input we've heard over and over again is that "We like your Nor116 sound level meter very much indeed, but quite a few of us would like to see that you add filters to it!"

Point taken! But, instead of just adding filters, we did a complete redesign of the hardware. Apart from the microphone cartridge and the preamplifier, there is now digital technology everywhere.

We added a new display with higher resolution and backlight, we added a larger memory, we added high-speed data transfer (up to 115200 baud!), we added the real time octave band and third-octave band filters and we extended the dynamic range!

One of the first things you'll notice when using the Nor118 is that there is no need to set the measurement range – simple and convenient!

We've added new functionality, but the old Nor116 had a lot features worth retaining. So we decided to keep the markers, the parallel time constants, the electronic level recorder and the sound power calculations.

To add further flexibility the Nor118 accepts prepolarised microphone cartridges as well as the conventional microphone cartridges designed for 200 V polarisation voltage.

There is more to this than just providing you with the option of using your existing stock of microphone cartridges – by reducing the polarisation voltage to 70 V (optional extension) the instrument will be able to measure levels up to 150 dB peak! The measurement range is then 20–140 dB RMS! Without the need for range setting!

As for all our sound measuring instruments, many of the features in the Nor118 are optional and can be added upon order or as retrofit whenever required. In this way you don't pay for features never used.

In this chapter we would like to introduce you to the Nor118 and explain to you some of its unique features. The Nor118 is a very powerful sound level meter – some would say it is more of a palm-size sound analyser – definitely made to measure!

No external modules

Different requirements and standards call for different functions to be measured. The Nor118 comes with an extensive set of functions available in its basic version. A multitude of other functions are available as optional extensions.

The modular design of the Nor118 enables functional expansion to take place when you need it and not necessarily at the time you purchase the instrument. Unlike certain other solutions commercially available, the Nor118 optional extensions remain in the instrument once installed and activated. There is no need for PC-cards to load and unload the extra modules every time you need other features.

The functions available

Even in the basic version the functions available with the Nor118 include the following

- SPL The Instantaneous Sound Pressure Level
- L_{MAX} The Maximum Sound Pressure Level
- L_{MIN} The Minimum Sound Pressure Level
- L_{eq} The Integrated Equivalent SPL
- L_E The Sound Exposure Level
- L_{PEAK} The Maximum Peak Level

The spectral weighting functions A- and C- or Z-weighting are available for all functions including the L_{PEAK}.

The Z-weighting will replace LIN or FLAT as these have not been properly defined by any standard. At the time of printing the Z-weighting appears in the draft for IEC 61672 likely to be approved as an international standard within short time.

As an optional extension the instrument functionality can be expanded to include the ability to measure with all three time constants (F, S, I) applied simultaneously.

The main features – an overview

Level vs. time. The electronic level recorder concept is available in two versions – basic and enhanced. While the basic version logs the equivalent level, the maximum level and the peak level, the enhanced version is capable of logging any combination of functions available with the Nor118. In addition it allows source coding.

Another difference important for some applications is that while the basic version has a time resolution ranging from 1 second and upwards, the enhanced version has a time resolution from 100 ms and upwards in 25 ms steps. Above 1 second the time resolution is available in 1 second steps for both versions.

Frequency analysis. When fitted with the frequency analysis extensions the Nor118 can do real time frequency analysis in octaves (8 Hz to 16 kHz) or third-octaves (6.3 Hz to 20 kHz).

The functions measured are the equivalent level, the maximum level and the minimum level.

Statistics. The optional extension 4 adds statistical distribution to the Nor118 functionality. There are eight percentiles shown, out of which one is freely selectable. The class width is 0.2 dB over the entire 120 dB range.

The statistical distribution calculations employs the F time constant and applies to the spectral weighting networks (A and Z or C) as well as all the individual filter bands (if applicable).

The back-erase feature, which deletes the ten most recent seconds of acquired global data prior to a pause upon resuming, updates the statistics buffers as well to maintain consistency.

Reverberation time. A typical Nor118 application is to serve as *the acoustician's little blue tool*. This will require the ability to calculate the reverberation time in octaves and third-octaves. Units without filters will calculate the broadband values (A- and C- or Z-weighted values). As usual, this is an optional feature so if you don't need it, you won't have to pay for it either.

The reverberation time algorithm is based on the *integrated impulse response* method, hence, impulses are required as excitation signals.

Sound power. Sound power levels may be calculated from sound pressure level measurements using almost any sound level meter.

However, the methods described in ISO 3746 (A-weighted measurements) involve a tedious calculation procedure before you end up with the single figure you need to be able characterise your measurement object.

So, why not let the Nor118 take care of this for you? Just specify the measurement surface type (hemisphere or parallelepiped), its dimensions and the location of your measurement object (on the floor, against a hard reflecting wall or in a corner) apply the correction factors and start your measurement. The sound power will then be calculated and displayed in tabulated form (available as optional retrofit later).

Noise monitoring and mapping. The large memory and the time synchronising capabilities of the Nor118 makes it well-suited as a front end in noise monitoring systems – outdoors for community noise as well as indoors in workshops etc.

The high dynamic range (120 dB) makes the setup easy and ensures reliable measurements in all situations.

The Norsonic product range contains a wide range of equipment and accessories for use with noise monitoring and measurements. We supply enclosures for permanent monitoring installations, environmental cases for semi-permanent installations, microphones for applications in tough environments, cables, modems, weather stations and post-processing software. A detailed presentation of this is available in a separate leaflet and on www.norsonic.com.

Real time frequency analysis

The all-digital technology used in the Nor118 made it natural to include filters – an important input from many of our customers.

We made them parallel right away, because you have already told us how important real time frequency analysis is to many of you.

Octave band or third-octave band measurements – the choice is yours, depending on how you prefer to configure your Nor118.

The octave band measurements span the range 8 Hz to 16 kHz, while an upgrade to option 3 will provide you with third-octave band measurements in the range 6.3 Hz to 20 kHz.

The two bandwidths share the type of functions measured. In a single frequency analysis the Nor118 measures:

- SPL The Instantaneous Sound Pressure Level
- L_{MAX} The Maximum Sound Pressure Level
- L_{MIN} The Minimum Sound Pressure Level
- L_{eq} The Integrated Equivalent SPL
- L_E The Sound Exposure Level

While the measurement is running the instantaneous SPL is available for inspection, but as soon as the measurement is terminated the SPL becomes meaningless and therefore not listed in the result tables.

If your Nor118 is equipped with parallel time constants (option 5) the list of functions measured simultaneously can be expanded to include functions with F, S and I time constants at the same time.

The frequency bands measured are all visible in the display with no need for horizontal scrolling. The f-t key lets you enter and exit the spectrum display.

Furthermore, the instrument measures the full frequency range – every time! Given the high dynamic range (120 dB), which eliminates the need for adjusting the gain, there is very little to set up before a frequency analysis can be made – successfully!

The measured functions are also available in tabulated form as numerical values. By pressing the TBL key before, during or after a measurement you have instant access to the numerical version. Another push on the key will restore the graphical display.

Frequency band statistics. Adding option 4 to your Nor118 will expand your frequency analysis to even calculate the statistical level distribution for each frequency band measured! In addition statistics will be calculated for the two spectral weighting networks employed (A- and C- or Z-weighting). The class width is always 0.2 dB to ensure sufficient resolution and the results are presented in the form of eight percentiles.

One of these percentiles is subject to user-definition and can be set to anything from 0.1% to 99.9%, both extremes included. Note that you don't have to define the percentile prior to the measurement. You may redefine the percentile as many times as you like – even after the measurement! For every frequency band measured!

However, once you store the measurement in the instrument's memory, only the selected percentiles will be available to keep the amount of data lower.

The fixed percentiles. The fixed percentile levels offered by option 4 are 1.0%, 5.0%, 10.0%, 50%, 90%, 95% and 99%.

For the statistical sampling the instrument makes use of the F time constant, irrespective of what time constant(s) the frequency analysis as such employs.

Time profile measurements

Remember the time when paper-based level recorders used to be the only way to capture the time profile of a sound measurement? Remember the struggle we all had with calibration and proper scaling of the plotting on the paper?

With Nor118 instruments equipped with the optional extension 6 you will be able to retain all the advantages of the level recorder principle, while at the same time discarding all the trouble!

No paper – no trouble. The optional extension 6 – level vs. time – records the time profile of the A-weighted equivalent level, the A-weighted maximum sound pressure level and the Z- or C-weighted peak level – simultaneously!

The principle is based on dividing the measurement into periods of identical duration. The period duration can be from 1 second and upwards in 1 second steps (from 100ms in enhanced mode).

When a level vs. time measurement is running, the equivalent level will be calculated per period, thus giving you the time profile for the measurement.

The MAX and the PEAK levels are also recorded per period so that all three functions will yield a value for every period. Everything is retained within the instrument, hence there is no paper involved in the process!

When you are going to make a measurement, the maximum number of periods at your disposal will depend entirely on the amount of free memory available. It will by no means depend on the duration of each period. This is because a period is a period in the sense that it will occupy a fixed space in the memory, irrespective of its duration.

Given the large memory of the Nor118 – the memory can hold approximately 2 500 000 values – the period duration will for all practical cases be determined by your need for time resolution.

Provide details – maintain overview. The level vs. time feature is the tool you need for detailed analysis of the time profile. However, a measurement failing to provide an overview of the entire analysis cannot be accepted.

So, we added a global analysis to all time profile measurements. It just runs in the background and makes little fuzz about its presence.

Switching between GLOBAL and PROFILE is easy, a dedicated key on the front panel – the Σ-Δ key – lets you toggle between the two. The Σ (pronounced "sigma") denotes the global analysis while the Δ (pronounced "delta") denotes the time profile.

Consequently, when you have set up for a time profile measurement by defining the total duration and the time resolution, you have in fact prepared the instrument for two parallel measurements – the global and the profile!

Absolute vs. relative time. If exact time information is important, just put the instrument in absolute time mode by pressing the key ABS t. All periods will then have the date and time of day they were acquired displayed. If time elapsed since start is sufficient push the key again to return to relative time. This is a display function – the absolute time is always recorded for all measurements.

Setting up is easy to do. After you've defined the duration and the resolution, all you need to do before you press the START key, is to define the time constant and whether to use Z- or C-weighting as the secondary spectral weighting function.

During the measurement you have instant access to the global analysis and profile. For each of these the function key lets you inspect all the functions measured.

For the global analysis the functions measured are

the instantaneous SPL, the maximum and the minimum SPL, the equivalent level, the sound exposure level and the maximum peak level. All levels are measured as A-weighted and Z- or C-weighted levels.

The time profile logs the A-weighted equivalent level, the A-weighted maximum sound pressure level and the Z- or C-weighted peak level.

The enhanced profile option. In need of even better resolution or better control of the functions measured? No problem! The time profile extension can be expanded into the enhanced profile extension – our option 7 for the Nor118. Order it when you purchase your Nor118 or later, if that suits you better.

In the enhanced mode, the instrument logs the time profile of the same functions as with the global:

- SPL The Instantaneous Sound Pressure Level
- L_{MAX} The Maximum Sound Pressure Level
- L_{MIN} The Minimum Sound Pressure Level
- L_{eq} The Integrated Equivalent SPL
- L_E The Sound Exposure Level
- L_{PEAK} The Maximum Peak Level

If you then add the option 5, parallel time constants, you may set up the instrument to log any combination of functions and time constants, for example the SPL with S time constant and the maximum SPL with F time constant simultaneously.

Enhanced time resolution as well. The enhanced profile has a time resolution which can be from 100 ms and upwards in 25 ms steps (in 1 second steps above 1 second time resolution), so beware unless you want to create a busy day for yourself – there will easily be quite a lot of data generated, so avoid more details than strictly needed!

Multispectral measurements

The Nor118 functionality can be expanded to include multispectral measurements. This extension takes the instrument's time profile capabilities to new heights by allowing complete spectra to be logged as a function of time.

Source coding

Have you ever made a measurement where you later found out that you desperately need to know what caused the level to be what it turned out to be?

Enter *source coding*. With the enhanced profile option you may tag or code sources as they happen. A one digit code (which appears in the display as 1~4) is entered to later serve as an identification of the type of noise. This can also be referred to as adding a marker to the measurement.

For example, in a traffic noise measurement a bus passing may be identified by the digit "1", while trucks may be identified by "2", unexpected vehicles by "3" etc. In the profile display the markers appear as dots or lines below the graph. If you move the time cursor onto such a dot, the marker type (i.e. its number) will appear in the display.

During a measurement, adding any of the markers 1, 2 and 3 will assign the corresponding marker number to the current period only. Adding marker number 4, however, will assign this marker to the current period plus all

consecutive periods until the marker again is deactivated. A typical application for marker 4 is to denote intervals of particular interest.

The keys to use. The keys used to enter the markers are CAL (marker 1), PRINT (marker 2), EXIT (marker 3) and ENTER (marker 4) since these keys are the lower most keys of the front panel and thus easy to reach during a measurement. None of these keys are used for other things during a measurement either.

Of course, the instrument will spend a little time storing the data (housekeeping). Therefore, if you start the session with hourly measurements exactly on the hour, long "store and go" sessions will – after a while – experience a small, but significant time shift, so that each period no longer starts exactly on the hour.

Enter *synchro mode*. This feature (standard in all models) stops the measurement slightly earlier to provide time for store and restart. By sacrificing a little at the end of a measurement the synchronisation with the time of day is retained, a feature important to many of our customers.

Excellent for noise monitoring

With the Nor118 you are able to do nearly all types of noise measurements – community noise, industrial hygiene, product control, noise mapping and more.

But, you don't need to attend the measurement sessions all the time. In fact, the Nor118 is able to do a lot on its own.

The measurement time can be preset to e.g. 30 minutes or an hour and the instrument put in a mode where it measures and stores the results, then starts measuring again, stores the results, starts measuring again and so on. Each measurement will be stored in a separate file, but all files are stored in the same directory, which has the name of today's date.

In this way the instrument will measure the periods you need. And, do not forget that if this *store and go* feature (which is standard) is combined with the optional time profile each measurement will provide global data and a time profile with a resolution specified by you!

The principle of optional extensions

The capabilities and setup options of your Nor118 will depend on which of the available extensions it has been equipped with.

Extensions are modules – made in hardware or made as software, in the instrument or e.g. as software for your PC – available for your Nor118. Norsonic extensions are always optional and hence often referred to as options. In this way you do not have to pay for features you're not going to use anyway.

However, you may find that your tasks are expanding into new areas of acoustics as time goes by. Therefore a typical Norsonic extension will be available for installation as retrofit.

Check which extensions are installed

Unless you are certain about the extensions installed in your Nor118, we recommend that you spend a little time looking into the matter.

The extension menu. Press SETUP > 1 > 0, although you won't find the 0 listed as an option in the Instrument setup menu.

The menu contains a unique ID code which identifies the very individual instrument whose menu you're looking at. In addition, the menu contains three codes. These codes enable the extensions activated for this instrument. The codes take the ID number into account and are valid for this individual instrument only.

- To leave the menu press ENTER. Note that the instrument will restart as a consequence of this.
- To leave the menu without restarting, press EXIT.

Note! The codes are unique for each instrument and will not work in other instruments. Do not change these codes as you will then loose the optional extensions installed and activated!

The options available. The below list was complete and exhaustive by the time of printing of this User Guide. However, constant improvements will normally result in new extensions becoming available on a regular basis. Check with your local Norsonic distributor or the factory for an update on this matter.

- Opt. 0: L_{Tmax5}, L_{eqI} and L_{eq} measurements according to German Standards.
- Opt. 1: ¹⁄₁-octave real-time filters 8–16.000 Hz
- Opt. 3: ¹⁄₃-octave filter bands.
- Opt. 4: Statistical calculations
- Opt. 5: Parallel F, S, I time constants
- Opt. 6: Basic time profile mode
- Opt. 7: Enhanced time profile mode
- Opt. 8: Multispectrum measurements
- Opt. 9: Reverberation time calculation
- Opt. 10: Sound power mode for L_{wA} measurements according to ISO 3746.
- Opt. 20: Extended measurement range enabling high-end range up to 150 dB peak, or low-end self-noise correction depending on microphone in-use.
- Opt. 21: Display output connector for use together with Video Interface Nor266. This option must be ordered at the same time as the new instrument.

Taking a closer look at the instrument

You may have to assemble the instrument the first time you use it. Be sure to take utmost care when mounting the microphone cartridge onto the preamplifier.

Always keep the preamplifier disconnected whenever you are screwing the cartridge onto the preamplifier and screw only finger tight!

The instrument is powered from four AA size batteries which are inserted as shown below. If you use rechargeable batteries, these will not be recharged if you connect the Nor118 to an external power supply.

The front panel keys all produce an audible click when depressed to confirm successful operation. However, the click is disabled during a measurement to avoid interference with low noise level measurement sessions.

Example of batteries inserted correctly

On the use of batteries

The Nor118 comes with four AA batteries (1.5 V each). Battery lifetime is typically 8–12 hours (depends on measurement mode and brand of batteries). If you switch to lithium batteries the life time will increase to 15–20 hours. The use of alkaline or lithium batteries is strongly recommended to avoid leakage.

Rechargeable batteries may also be used, but with reduced operating time. Connecting an external DC-source (11–15V) to the instrument will not charge rechargeable batteries, but power the instrument *in lieu* of the internal batteries.

The internal calendar/clock is powered by an integrated battery with approximately ten years of battery life-time.

No recharging. Connecting an external DC-source (11–15V) to the instrument, will not charge rechargeable batteries, but power the instrument *in lieu* of the internal batteries.

Battery Voltage vs. Time

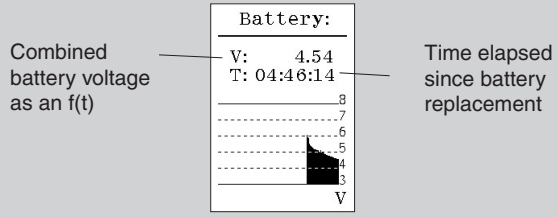
The Nor118 offers a graphic presentation of the battery-versus-time history.

To display the battery voltage vs. time:

- Press the BATT key. Press again to exit the menu.

Battery voltage

Battery voltage is presented graphically as f(t). Press the batt key to produce this display and press again to exit the display.



The display will now indicate the combined voltage of the four batteries and the use-time elapsed since the batteries were replaced. The graph is updated every sevenminutes and each pixel corresponds to seven minutes in the horizontal direction and 0.25V in the vertical direction.

When the combined battery voltage drops below 3.9 V, a battery low indicator appears in the display and the instrument will start to shut itself off. Any ongoing measurement will be terminated and stored in a directory called BATLOW. Memory contents is retained without the use of electrical power (flash memory).

If the instrument is connected to an external DC-source, the external-source-voltage vs. time will be shown without voltage and use-time information (empty graph).

If powered from internal batteries and left unattended and unoperated, the Nor118 will switch itself off after ten minutes. However, this does not apply if the instrument is measuring (including being paused during a measurement, not when powered from an external source.

Setting the polarisation voltage

To set the polarisation voltage:

- Press SETUP > INSTR. > 4 (POL.VOLT) and use the VERTICAL CURSOR KEYS to select 200 V polarisation voltage ON or OFF.

Polarisation voltage

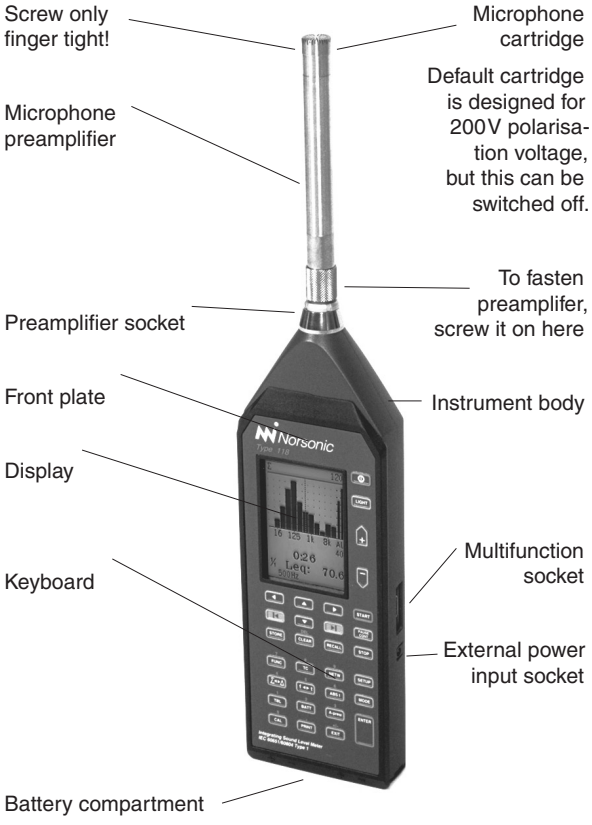
The polarisation voltage setting menu opens up for the use of prepolarised microphone cartridges.

A prepolarised microphone cartridge will normally exhibit reduced sensitivity when exposed to polarisation voltage. It will regain its initial sensitivity shortly after the polarisation voltage is no longer applied. A conventional cartridge will appear "dead" until shortly after the polarisation voltage is switched ON and then it will work OK.

The above applies to all microphone cartridges supplied by Norsonic. However, a universal guarantee for all brands cannot be granted. Norsonic is not liable for consequential damages of the use of polarisation voltage

Navigating in the menus. Observe the following general guidelines applicable to every Nor118 menu:

- To navigate between editable parameter fields in the menu, use the CURSOR keys
- The editable field currently selected is shown inverted (white text on black background)
- Use the ARROW keys to right of the display (the INC and DEC keys) to increment or decrement the current setting of the parameter. Alternatively use the keypad to key in the required value, whenever applicable. The # sign will appear in the lower line of the display whenever the instrument accepts numerical inputs
- If you use the NUMERICAL KEYPAD, be sure to press ENTER before moving to the next field to alter. This is not needed when you use the INC and DEC keys.
- To leave the menu putting changes into effect press ENTER.
- There is no CANCEL function available.



Setting the time and date

To set the time and date:

- Press SETUP > 1 (INSTR.) >3 (CLOCK). Use the cursor keys to navigate in the menu and INC and DEC to alter a setting or use the NUMERICAL KEYPAD to key in a value. Numerical inputs must be terminated by ENTER to enable navigation between the parameter fields again. Press ENTER to leave the menu putting changes into effect (i.e. setting the time and date).

Clock
The date and time setting menu. Press SETUP > 1 (Instr.) > 3 (Clock) to produce this menu.

```
Clock:

 Y : M : D
01:10:13

 H : M : S
18:27:24

      #
```

The front panel keys of the Nor118

Cursor keys to navigate in the menus and to operate the graph cursors

Causes the graph cursor to jump one screenwidth in either direction

Memory handling

Select function to be displayed

Select time constant

Select spectral weighting network

Σ (Global) or Δ (Profile) domain

Time or frequency domain

Absolute time on/off

Tabulation of results

Battery status

Graphical on-screen A-weighting

Calibration men

Generate printouts

Power on/off

Display backlight on/off

Increment and decrement a parameter setting

Start a measurement

Pause and resume a measurement

Stop a measurement

Setup menus

Instrument mode

Leave a menu putting changes into effect

Exit certain menus

Calibrating the instrument

Calibration is the normal way of ensuring that the sound level meter measures the level with sufficient accuracy. To calibrate we need a sound calibrator.

The use of sound calibrators dates back to the days when it was easier to design a stable sound calibrator than a stable sound level meter. Today, sound measuring instruments are, in general, as stable as the sound calibrators.

However, measuring microphones are very delicate devices designed to fulfil very rigid specifications. This makes them vulnerable and subject to damage unless proper care is taken.

One may therefore say that a sound calibrator is just as much a verification of proper operation as it is a device of adjusting the sensitivity of sound measuring instruments.

The Nor118 is calibrated by means of menus and key pushes – there is no need for a screwdriver to turn a potentiometer!

When to calibrate

Calibration of the Nor118 should preferably take place before a measurement session is commenced, or whenever required by applicable standards. If you know the microphone cartridge sensitivity, you may key this in using the numerical keypad. However, doing so will never replace calibration with a sound calibrator, as the sensitivity adjustment procedure will be unable to reveal possible microphone, preamplifier or extension cable malfunctions.

No need to adjust the full scale setting

Since the Nor118 has a 120 dB dynamic range (10–130dB spl), the 80 dB bar graph range is a display limitation only. Hence, you won't have to bother with setting the full scale before you enter the *Calibration* menu.

Furthermore, since the Nor118 automatically enters c-weighted mode, you won't have to bother with the calibrator frequency either.

However, you may have to adjust the display top scale setting to *see* the top of the bar graph. Use the inc and dec keys for this *before* you enter the calibration menu.

Carrying out the calibration

You will need a sound calibrator of sufficient accuracy, i.e. a class 1 or class 0 sound calibrator as defined by the iec 60 942 standard such as the Norsonic sound calibrator Nor1251 or Nor1253. Do as follows:

1 **Enter calibration mode**. Press the CAL key to gain access to the *Calibration* menu. The display will typically look as shown to the right.

2 **Know the output level of your sound calibrator.** Some sound calibrators have an output level of 94dB, while others (like the Nor1251 which is used in the example to the right) have an output level of 114dB or even 124dB (like the Nor1253). Unless you know the output level of your sound calibrator you won't be able to know what level the measuring instrument is supposed to show. The output level is normally printed on the sound calibrator or stated in its accompanying user documentation.

3 **Free-field microphones require lower settings.** Be aware of the fact that instruments using free-field microphones shall be adjusted to a value slightly lower than the output level of the sound calibrator. For a half-inch cartridge this will typically amount to 0.2 dB lower for calibrators producing a 1000 Hz calibration signal (e.g. the sound level meter should then be set to 113.8 dB when using a 114 dB @ 1 000 Hz sound calibrator) Other frequencies will require different correction values, see the *Field calibration* side bar (overleaf) for more on this.

4 **Mount the calibrator onto the sound level meter.** Mount the sound calibrator onto the microphone as shown to the right. Switch on the sound calibrator and wait until the level has stabilised. Information on how long time this will take should be available from the documentation accompanying your sound calibrator.

5 **Set the sensitivity.** To set the sensitivity correctly use the INC and DEC keys (the + and the – keys located

The sound calibrator should be mounted onto the microphone as shown here. Do not use the EXIT key to leave the calibration menu – see text for details.

Field calibration. The recommended sound calibrator for verification of the sound level meter Nor118 is the *Norsonic Nor1251* with a nominal sound pressure level of 114.0 dB @ 1kHz. In order to compensate for diffraction effects around the microphone, we recommend adjusting the sound level meter to indicate 113.8 dB (diffuse correction off).

If other types of calibrators or electrostatic actuators are to be used for the calibration, we recommend adjusting the sound level meter to indicate the following levels referred to the sound pressure level acting on the microphone's diaphragm (diffuse correction off):

f [Hz]	125	250	1000	4000	8000
Corr. [dB]	0.0	0.0	–0.2	–0.8	–2.8

The diffuse correction is activated and deactivated in the *Corrections* menu. Press SETUP > 1 (INSTR.) > 6 CORRECT.)

Navigate in the menu using the ARROW keys and use INC or DEC to activate/deactivate the Random setting. Activated Random setting is indicated by an R in the lower line of the display.

to the right of the display) while at the same time watching the level read-out. Alternatively, you may key in the required sensitivity using the NUMERICAL KEYPAD. Once the correct level reading is established press ENTER to leave the menu.

6 **Do not use EXIT to leave the menu**! The EXIT key will be interpreted as the ± sign whenever the Nor118 expects numerical inputs (indicated by the # sign appearing in the lower line of the display). Hence pressing EXIT will not cause the instrument to leave the menu, but instead insert the ± sign. Typically you will now press ENTER since EXIT didn't work. The result is that you have inserted 0 as the sensitivity setting and consequently your measurements will all be wrong. To fix this, press the CAL key again and enter –26 dB as the sensitivity value before you calibrate the unit again.

The dB value corresponds to the sensitivity level of the microphone cartridge; dB relative to 1 volt/pascal, e.g. 50 mV/Pa corresponds to –26.0 dB. The instrument may also be set up to compensate for the attenuation taking place in the preamplifier, which normally amounts to 0.1–0.2 dB – see *Preamplifier attenuation* in the *Technical specifications* for more on this.

Simple sound measurements

Despite all its advanced capabilities, the Nor118 may still be used as a simple sound level meter. The only thing you really need to set up is the measurement duration, which at least must be set up to match the amount of time you intend to be measuring. If it is set to a longer time, this will constitute no problem – just press the STOP key when you want to terminate an ongoing measurement.

However, you should consider the settings of the time constant and the spectral weighting (C- or Z-weighting, see *Setting c or z as spectral weighting network* for more on this) also, but once they are set, the instrument will remember these until they are changed to something else.

Setting the duration

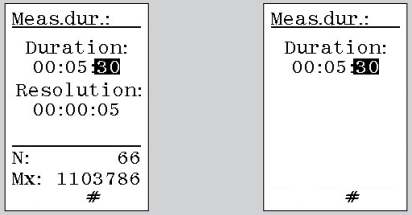
Your instrument may, or may not be equipped with the optional extension 6, which is the time profile logging. This affects the look of the measurement duration setup menu. To read more about optional extensions see *The principle of the optional extensions*.

How the menu looks with and without the optional extension 6 installed is shown overleaf.

Navigating in the menus. Observe the following general guidelines applicable to every Nor118 menu:

- To navigate between editable parameter fields in the menu, use the CURSOR keys
- The editable field currently selected is shown inverted (white text on black background)
- Use the ARROW keys to right of the display (the INC and DEC keys) to increment or decrement the current setting of the parameter. Alternatively use the keypad to key in the required value, whenever applicable. The # sign will appear in the lower line of the display whenever the instrument accepts numerical inputs
- If you use the numerical keypad, be sure to press ENTER before moving to the next field to alter. This is not needed when you use the INC and DEC keys.
- To leave the menu putting changes into effect press ENTER.
- There is no CANCEL function available.

Measurement duration setup menu



Measurement duration setup menu when time profile option is installed (left), and when it's not (right).

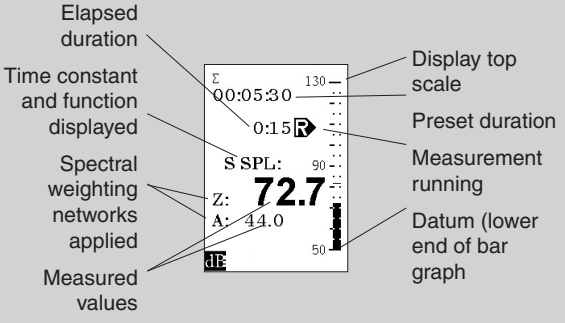
To produce the measurement duration setup menu:

- Press SETUP > 2. To leave the menu press the ENTER key.

Statistics

Even if your instrument is equipped with the optional extension 4 – statistics, the percentiles table will fail to produce values for all percentile settings unless the measurement duration is sufficiently long – see the *Missing percentiles* side bar below left for more on this.

The sound level meter display



Missing percentiles? There may be percentiles that fail to produce values in the table. This is because you have not measured for a time long enough to provide the necessary number of samples.

Statistical sampling – which should not be confused with the sampling of the analogue-to-digital conversion – takes place 10 times a second. For comparison, the sampling of the analogue-to-digital conversion runs at 48 kHz!

Since the statistical sampling takes place 10 times a second, it will take 10 seconds to produce 100 samples. You will need at least 100 samples to be able to calculate the 1% percentile.

Likewise, for the 0.1% percentile the minimum time required will be 100 seconds. Measurements whose duration are shorter than these minimum limits will not produce percentile values for all possible settings of the percentiles.

Going to measure very high levels? As an optional extension the Nor118 is able to measure very high sound pressure levels without changing the microphone cartridge – see *High levels* in the *Technical specifications* for details.

Instruments with time profile installed

If your instrument has the time profile installed, you should set the resolution to the same value as the duration to avoid that the instrument starts logging the level as a function of time.

Setting the time constant

If your instrument is *not* equipped with the optional extension 5 – parallel time constants, you may want to specify the time constant to be used in the measurement. The time constant is used for the SPL, the L_{MAX} and the L_{MIN} measurements, but neither the L_{eq}, the L_E nor the L_{PEAK} makes use of it.

To set the time constant press the TC key until the required time constant appears in the display. To see this, be sure to operate the FUNC key until any of the functions SPL, the L_{MAX} or the L_{MIN} appears in the display first.

If your unit is equipped with multiple time constants, you need not bother with this.

Instruments with multiple time constants

Instruments equipped with multiple time constants will always employ all three time constants (F, S and I) for all measurements. The time constants apply to the SPL, the L_{MAX} and the L_{MIN} functions. L_{eq}, L_{PEAK} and L_E do not make use of time constants. However, units configured for German-speaking markets will also measure the L_{eqI}.

The presence of multiple time constants eliminates the need for setup of the time constant.

Multiple time constants and statistics

Observe that the statistics buffers (optional extension) will be based on sampling using time constant F. This cannot be changed by the user.

C or Z as spectral weighting network

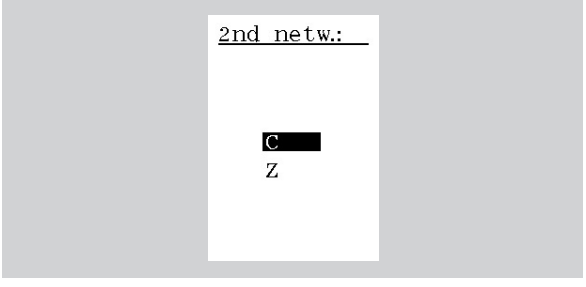
The Nor118 has three spectral weighting functions in addition to the filter bands. These are A-weighting and C- or Z-weighting. The Z-weighting is a replacement for the previous FLAT or LINEAR spectral weighting functions. A problem when dealing with these functions has been that none of them are properly defined in any standard.

The Z spectral weighting circuitry is flat within at least 16Hz to 16kHz (in the Nor118 it extends far beyond that – viz. 20–20 000 Hz +0 –1 dB) and is well-defined in an upcoming standard (FDIS IEC 61672).

The Nor118 can make use of two of the three spectral weighting functions simultaneously – viz. A-weighting and Z- or C-weighting.

To specify whether to use Z- or C-weighting:

- Press SETUP > 1 (INSTRUMENT) > 5 (2ND NETW) and navigate in the menu as usual.



Making a measurement

To start a measurement:

- Press the START key. The **R** in the display indicates that a measurement is running.

To temporarily halt an ongoing measurement:

- Press the PAUSE/CONT key.

To resume a paused measurement:

- Press the PAUSE/CONT key again. Upon resuming the instrument will go on measuring until the total measurement time elapsed equals the preset duration. Observe that data acquired the ten seconds immediately preceding the pause will be erased because of the back-erase function (see below).

What can be done to the measured data? Data acquired are available for inspection, during or after a measurement.

You may:

- Display the functions measured
- Display the result table
- Change the spectral weighting function between A- and C- or Z-weighting
- Display the eight percentiles and set one of them as you like
- Store them for future use

To terminate an ongoing measurement:

- Press the STOP key.

To resume a terminated measurement:

- To resume a terminated measurement press the PAUSE/CONT key again. Upon resuming the instrument will go on measuring until the total measurement time elapsed equals the preset duration. When a terminated measurement is resumed, the back-erase feature (see below) will *not* be activated.

To switch between absolute and relative time:

- To switch between time elapsed since start of measurement (relative time) and date + time of day (absolute time), use the ABS t key.

To display other functions measured,

- Use the FUNC key. For the German-speaking markets these functions will include LeqI and TMax5

To adjust the display top scale:

- If the bar graph fails to match the level measured use the INC and DEC keys (the vertical arrow keys to the right of the display) to alter the display top scale setting.

To switch between the spectral weighting functions:

- Use the NETW key to switch between A-weighted and C- or Z-weighted or the A-weighted and the C–A (Z–A) weighted functions.

To produce the results in tabulated form:

- Press TBL to produce a result table. See *Displaying the result tables* for more on this.

Resuming an ended measurement

Assume that you have set up the instrument to measure for 5 minutes and that you start the measurement. After 5 minutes the measurement will end since the measurement time elapsed equals the preset duration. The measurement has now ended successfully, as opposed to if you press the STOP key to forcefully terminate an ongoing measurement.

If you now press the PAUSE/CONT key, the instrument will resume the measurement and go on measuring for another 5 minutes so that the total measurement time assumes 10 minutes, i.e. twice the initial setting. If you do this again, the total measurement time will be 15 minutes, i.e. three times the initial setting and so on.

This way of prolonging a measurement will not activate the back-erase feature (see below for more on this).

The back-erase feature

When you press the PAUSE/CONT key during an ongoing measurement, the instrument will temporarily halt the measurement. Pressing the key again will cause the instrument to resume the measurement while at the same time erasing the data acquired during the last 10 seconds immediately preceding the pause.

If the measurement has been running for less than 10 seconds when you press the PAUSE/CONT key, the entire measurement will be erased upon resuming the measurement.

If less than 10 seconds have elapsed since the last time you resumed a paused measurement, only the part of the measurement acquired since the last resume will be erased. Data acquired earlier are assumed to be accepted by you.

The measurement time elapsed counter will be updated to reflect the back-erase. Note that the statistics buffers (optional extension) will be updated similarly.

Displaying the functions measured

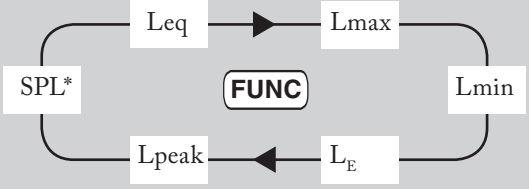
The instrument measures the SPL, L_{MAX}, L_{MIN}, L_{eq}, L_E and the L_{PEAK}. Note that the SPL, L_{MAX} and L_{MIN} are all measured with the selected time constant while the rest do not make use of the time constant at all.

During measurements the SPL value is updated every second. Once the measurement is over, the SPL becomes meaningless. A single SPL value cannot be used to characterise the measurement unless it represents some kind of maximum, minimum or time-integrated average. It is thus not accessible post measurement.

To return to READY mode, i.e. how the instrument behaved before the measurement was started press the EXIT key. You will be prompted to store the data or press

The functions are available sequentially

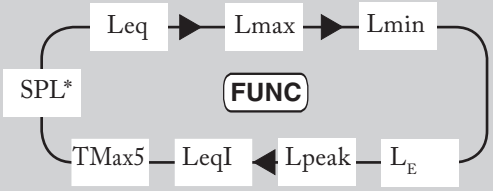
To display a certain function, press the FUNC key repeatedly until the function appears. The sequence is as follows:



*Accessible during measurement only – not after!

Units configured for the German-speaking markets

If also equipped with L_{eqI} and T_{Max5}, the sequence is as follows (press FUNC key repeatedly):



*Accessible during measurement only – not after!

Units with multiple time constants

Units with multiple time constants will measure the L_{MAX} and L_{MIN} with all three time constants (F, S, I) employed simultaneously.

During – but not after – a measurement, the SPL will also be available for display.

To view one of the functions as measured with another time constant, use the FUNC key to produce the function and then press the TC key once or twice.

EXIT again. In both cases the instrument will go back to READY mode. The SPL will now be displayed again.

If you choose not to store the data (i.e. you did press EXIT a second time) the measured data will be lost beyond retrieval. Storing is dealt with later.

Displaying the result tables

As an alternative to the above procedures, you may display all the data in a single table. Press the TBL key to produce the result table. This feature is available during as well as after a measurement. Do not forget that SPL values are only shown during a measurement – never once the measurement is over!

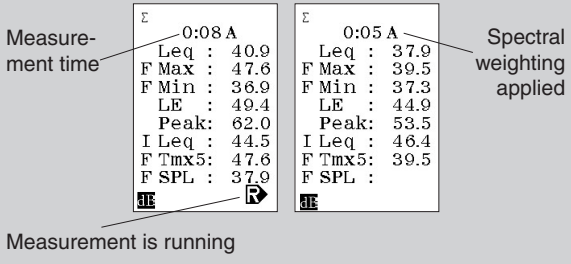
To produce the table of measured results using the other spectral weighting function press the NETW key while in the table.

There are two spectral weighting functions available A- and C- or Z-weighting. The latter should be set by you prior to the measurement.

Even before you enter the table you may use the NETW key to view the results of applying the two spectral weighting functions.

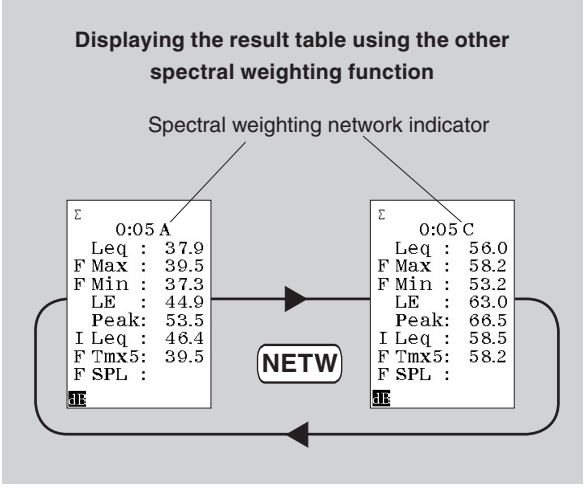
The result table

Once you've pressed the TBL key, the display will typically look like this:



Observe that once the measurement no longer is running, no SPL value is available.

Units *not* configured for the German speaking markets will have tables not containing the I L_{eq} (L_{eqI}) and T_{mx5} values.



The actual spectral weighting function used in the table depends on the setting active before the TBL key was pressed. At any rate, press NETW to toggle between primary and secondary weighting function.

Statistics – displaying the percentiles

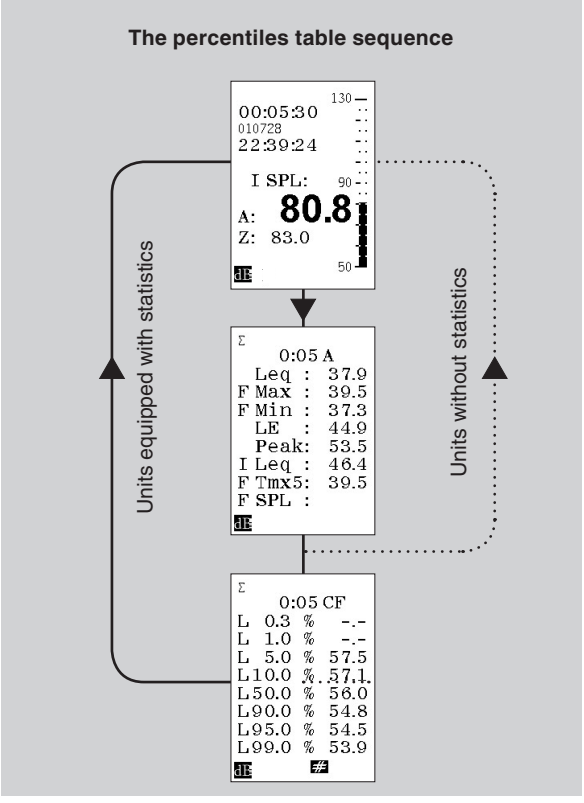
Instruments equipped with the optional extension 4 – statistics – will measure the statistics every time. This cannot be switched off.

The sampling for the statistical calculations is made with F time constant and the class width is 0.2 dB over the entire 120 dB dynamic range – always!

You may think that storing all these data will require a huge memory, and you're absolutely right. Therefore, we refrain from that, we store just eight percentiles instead. Seven of them are fixed and one is user-editable.

Your user-editable percentile can be set to anything in the range 0.1–99.9 %, both extremes included. The procedure is explained overleaf.

Data measured, but not yet stored may be subject to changes in the user-defined percentile. This means that as long as you have not stored the acquired data, you may change the percentile as many times as you want, but once the data are stored any changing of the user-editable percentile is no longer possible.

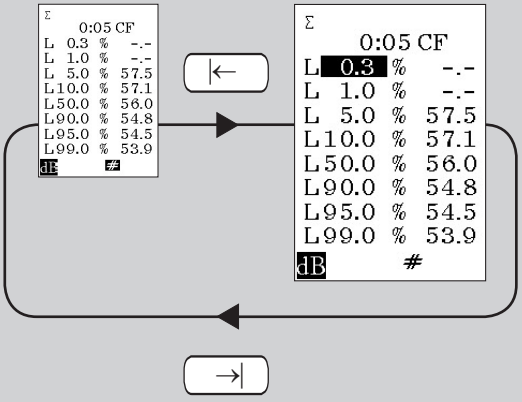


Editing the user-defined percentile

To enable the editing the instrument must display the percentiles table. In the percentiles table press the |← key (the END-LEFT key) to enable this.

Once the percentile field is shown inverted (with white text on black background) the text can be edited using the NUMERICAL KEYPAD or INC and DEC. If you use the NUMERICAL KEYPAD you must press ENTER to confirm that you have keyed in the new percentile.

To terminate the editing process press the →| (END-RIGHT key). The corresponding percentile value will now be displayed, given that the measurement duration was long enough to provide a sufficent number of samples. Using ENTER will not work here.



The user-defined setting applies to both spectral weighting settings. The two cannot have individual settings!

Displaying the percentiles table

To produce the percentiles table press TBL to enter the result table and TBL *again* to enter the percentiles table. Units not equipped with the statistical extension will exit the table upon the second push on TBL and return to the sound level meter display mode. The sequence is shown in the side bar.

Storing the acquired data

The Nor118 has a large, non-volatile memory to hold the measurements. The memory structure resembles the memory structure of a personal computer in the sense that both use folders and files.

The structure of the Nor118 is very simple, the folder has the name of today's date and the files are numbered consecutively from 0001 and upwards. Consequently, the maximum number of measurements per day is 9998, but this should be a limitation most people will be able to live with. After all, you are going to look through these files later as well, aren't you?

Storing the acquired data:

- Press the STORE key. The display will show the folder and file number.

All aspects of the memory handling are discussed in detail in *Memory handling*.

Printing out the results

By connecting a printer to the RS232 interface, the results can be output to a printer. This is treated in detail in *Making hardcopies*.

Frequency analysis

As an optional extension, you may have your Nor118 equipped with parallel octave band filters. By adding the optional extension 3, third-octave band filters become available as well. The frequency range, expressed as centre frequencies, is 8–16 000 Hz for the octave band filters and 6.3–20 000 Hz for the third-octave band filters.

When you make a frequency analysis, this comes in addition to the traditional sound level measurement as described in the chapter *Simple sound measurements*.

Setting up

The frequency range is fixed and cannot be changed by the user. Bearing in mind that the dynamic range of the Nor118 is no less than 120 dB and that the instrument measures a fixed set of functions (which cannot be altered by you), there is not much left to set up before the instrument is ready to make a frequency analysis.

Actually, the setup procedure boils down to specifying the measurement duration, the time constant to be used and the use of c- or z-weighting, ensuring that the frequency mode has been activated and – in case of extension 3 present – specifying the filter bandwidth.

Setting the duration

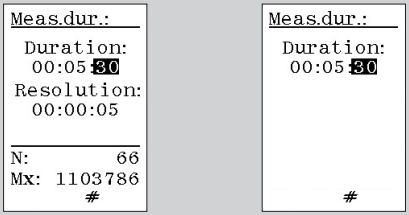
Your instrument may, or may not be equipped with the optional extension 6, which is the time profile logging. This affects the look of the *Measurement duration setup* menu. To read more about optional extensions see *The principle of the optional extensions*.

How the menu looks with and without the optional extension 6 installed is shown below.

To produce the measurement duration setup menu:

- Press SETUP > 2. To leave the menu press the ENTER key.

Measurement duration setup menu



Measurement duration setup menu when time profile option is installed (left), and when it's not (right).

Instrument without the multispectrum extension (option 8) are not able to capture the spectrum as a function of time. However, instruments equipped with the time profile extension – the basic version as well as the enhanced version – may log the A- and C- or Z-weighted levels as functions of time in parallel with the overall frequency analysis described in this chapter.

Details on the logging of the level vs. time can be found in the chapters *Basic time profile measurements* and *Enhanced time profile measurements*.

Statistics

Even if your instrument is equipped with the optional extension 4 – statistics, the percentiles table will fail to produce values for all percentile settings unless the measurement duration is sufficiently long – see the *Missing percentiles* side bar in this chapter for more on this.

Instruments with time profile installed

If your instrument has the time profile installed, you should set the resolution to the same value as the duration to avoid that the instrument starts logging the level as a function of time – like the classic level recorders used to do. Unless you want this to take place, of course.

Instruments equipped with the *Multispectrum* extension (option 8) may also log the spectrum as a function of time. This is treated in chapter 9 *Multispectrum measurements*.

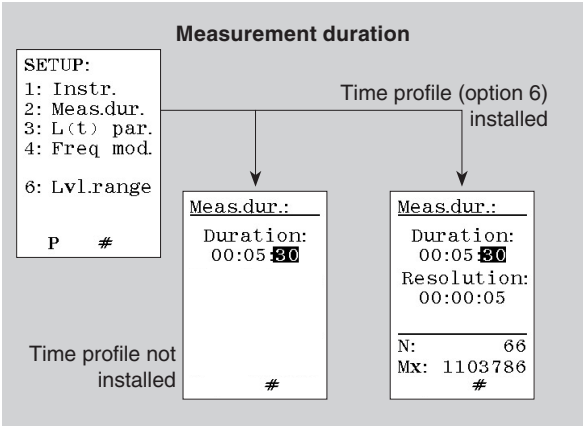
Cf. *Basic time profile measurements, Enhanced time profile measurements* and *Multispectrum measurements* for details on logging the level vs. time with or without the spectrum as a function of time.

Consider setting the time constant

If your instrument is not equipped with the optional extension 5 – parallel time constants (see *Units equipped with multiple time constants*), you may want to specify the time constant to be used in the measurement.

The time constant is used for the SPL, the L_{MAX} and the L_{MIN} measurements, but neither L_{eq} nor L_E make use of it.

To set the time constant press the TC key until the required time constant appears in the display. To see this, be sure to operate the FUNC key until any of the functions SPL, the L_{MAX} or the L_{MIN} appears in the display first.



Setting C or Z as spectral weighting network

The Nor118 has three spectral weighting functions in addition to the filter bands. These are A-weighting and C- or Z-weighting. The Z-weighting is a replacement for the previous FLAT or LINEAR spectral weighting functions. A problem when dealing with these functions has been that none of them are properly defined in any standard.

The Z spectral weighting circuitry is flat within at least 16 Hz to 16 kHz (in the Nor118 it extends far beyond that) and it is well-defined in an upcoming standard (FDIS IEC 61672).

The Nor118 can make use of two of the three spectral weighting functions simultaneously – viz. A-weighting and Z- or C-weighting.

To specify whether to use Z- or C-weighting:

- Press SETUP > 1 (INSTRUMENT) > 4 (2ND NETW) and navigate in the menu as usual.

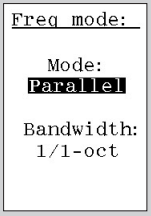
The A-weighted value and the C- or Z-weighted value will appear as extra bar graphs to the right of the spectrum in the display.

Going to measure very high levels?

As an optional extension the Nor118 is able to measure very high sound pressure levels without changing the microphone cartridge – see *High levels* in the *Technical specifications* for details.

Menu for the activation of the frequency mode

Press SETUP >1>4 to produce this menu



Activating the frequency mode

In order to enable frequency analysis, the frequency mode must be activated.

Activating frequency mode:

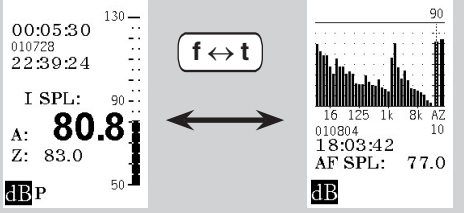
- Press SETUP > 4 (FREQ MOD.) to gain access to the frequency mode menu. Navigate in the menu as usual. Set the bandwidth as required.

As long as the frequency mode has been activated, frequency analysis will be made during every measurement. This means that the instrument will combine a "traditional" sound level meter measurement and a real time frequency analysis in octaves or third-octaves. Whether the instrument is set to show the spectrum or the classic sound level meter display will not affect the measurement in any way. Likewise, going between the two display modes during a measurement has no effect on the measurement either.

Switching to displaying the spectrum

Having activated the frequency mode and left the menu, just press the f↔t key to display the level vs. frequency and press again to return to the other display. Since no measurement has been made the only function producing frequency band bar graphs will be the SPL with the selected time constant. If you press the FUNC key this will produce empty displays only. If you did, just keep pressing the FUNC key until the SPL reappears.

Switching between sound level meter display and spectrum display



Sound level meter display

Spectrum display

Making a frequency analysis

To start a frequency analysis measurement:

- Press the START key. The **R** in the display indicates that a measurement is running. The measurement is running and data acquired irrespective of whether the frequency spectrum is shown or not.

To temporarily halt an ongoing measurement:

- Press the PAUSE/CONT key.

To resume a paused measurement:

- Press the PAUSE/CONT key again. Upon resuming the instrument will go on measuring until the total measurement time elapsed equals the preset duration. Observe that data acquired the ten seconds immediately preceding the pause will be erased because of the back-erase function (see below).

To terminate an ongoing measurement:

- Press the STOP key.

To resume a terminated measurement:

- To resume a terminated measurement press the PAUSE/CONT key. Upon resuming the instrument will go on measuring until the total measurement time elapsed equals the preset duration. When a terminated measurement is resumed, the back-erase feature (see below) will *not* be activated.

To switch between absolute and relative time:

- To switch between time elapsed since start of measurement (relative time) and date + time of day (absolute time), use the ABS t key.

To display other functions measured,

- Use the FUNC key. For the German-speaking markets these functions will include LeqI and TMax5

To switch between sound level meter display and spectrum display:

- Press the f↔t key

To make the spectrum appear A-weighted

- Press the A-PREW key. The display will now appear A-weighted. This is purely a display function and it has no effect whatsoever, on the measured data.

To move the graph cursor about the frequency bands

- Use the ← & → keys. Use the |← & →| keys to move to the extreme left and extreme right.

To adjust the display top scale:

- If the bar graph fails to match the level measured use the INC and DEC keys (the vertical arrow keys to the right of the display) to alter the display top scale setting.

To switch between the spectral weighting functions:

- Use the NETW key to switch between A-weighted and C- or Z-weighted or the A-weighted and the C–A (Z–A) weighted functions.

To produce the results in tabulated form:

- Press TBL to produce a result table.

Resuming an ended measurement

Assume that you have set up the instrument to measure for 5 minutes and that you start the measurement. After 5 minutes the measurement will end since the measurement time elapsed equals the preset duration.

The measurement has now ended successfully, as opposed to if you press the STOP key to forcefully terminate an ongoing measurement.

If you now press the PAUSE/CONT key, the instrument will resume the measurement and go on measuring for another 5 minutes so that the total measurement time assumes 10 minutes, i.e. twice the initial setting. If you do this again, the total measurement time will be 15 minutes, i.e. three times the initial setting and so on.

This way of prolonging a measurement will not activate the back-erase feature.

The back-erase feature

When you press the PAUSE/CONT key during an ongoing measurement, the instrument will temporarily halt the measurement. Pressing the key again will cause the instrument to resume the measurement while at the same time erasing the data acquired during the last ten seconds immediately preceding the pause.

If you've measured for less than ten seconds

If the measurement has been running for less than 10 seconds when you press the PAUSE/CONT key, the entire measurement will be erased upon resuming the measurement.

If less than 10 seconds have elapsed since the last time you resumed a paused measurement, only the part of the measurement acquired since the last resume will be erased. Data acquired earlier are assumed to be accepted.

The measurement time elapsed counter will be updated to reflect the back-erase. Note that the statistics buffers (optional extension) will be updated similarly.

Displaying the functions measured

The instrument measures the A-weighted and C- or Z-weighted SPL, L_{MAX}, L_{MIN}, L_{eq}, L_E and the L_{PEAK}. Note that the SPL, L_{MAX} and L_{MIN} are all measured with the selected time constant while the rest do not make use of the time constant at all.

The same functions are available in the frequency analysis with the exception of L_{PEAK}. The peak level is not measured per frequency band. In addition, T_{Max5} is not available for frequency analysis (applies to units equipped with the optional extension 0).

However, since the frequency analysis is made in parallel with the traditional (A- and C- or Z-weighted) sound level measurement, the broadband peak levels and the T_{Max5} levels are still assessed during the measurement.

No SPL after the measurement

During measurements the SPL value is updated every second. Once the measurement is over, the SPL becomes meaningless. A single SPL value cannot be used to characterise the measurement unless it represents some kind of maximum, minimum or time-integrated average. It is thus not accessible *post-measurement*.

What can be done to the measured data? Data acquired are available for inspection, during or after a measurement.

You may:

- Switch between sound level meter display and frequency spectrum display
- Display the functions measured
- Display the result tables
- Change the spectral weighting function between A- and C- or Z-weighting, this depends on which one you measured
- Display the eight percentiles (requires the presence of the optional extension 4) and set one of them as you like
- Store them for future use

To return to READY mode, i.e. how the instrument behaved before the measurement was started press the EXIT key. You will be prompted to store the data or press EXIT again. In both cases the instrument will go back to ready mode. The SPL will now be displayed again.

If you choose not to store the data by pressing EXIT again, the measured data will be lost beyond retrieval.

Displaying the result tables

As an alternative to the procedures shown on the next page, you may display all the measured data in tables. Press the TBL key to enter table mode. Note that the look of the tables depends on whether you start from sound level meter display mode or from frequency spectrum mode.

The tables are available during, as well as after a measurement. Remember that SPL values are shown during the measurement only.

The tables available are shown in the side bar *Displaying the result tables*.

Statistics – displaying the percentiles

Instruments equipped with the optional extension 4 – statistics – will measure the statistics every time. This cannot be switched off.

The sampling for the statistical calculations is made with F time constant and the class width is 0.2 dB over the entire 120 dB dynamic range – always! When the frequency mode has been activated, the instrument does statistics in every frequency band!

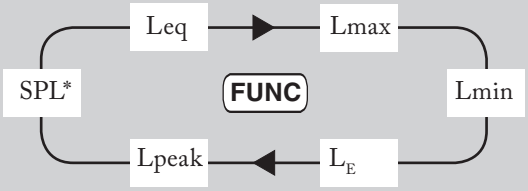
You may think that storing all these data will require a huge memory, and you're absolutely right. Therefore, we store just eight percentiles. Seven of them are fixed and one is user-editable.

Instruments configured for the German-speaking markets will measure L_{eqI} (with I time constant) and TMAX5 (with F time constant) in addition – see below.

The LPEAK and TMAX5 are not accessible when the spectrum is displayed!

The functions are available sequentially

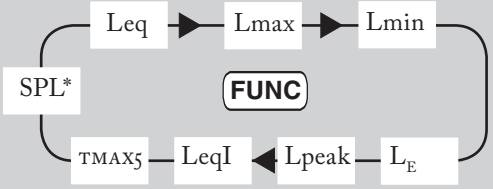
To display a certain function, press the FUNC key repeatedly until the function appears. The sequence is as follows:



*Accessible during measurement only – not after!

Units configured for the German-speaking markets

If also equipped with L_{eqI} and TMAX5, the sequence is as follows (press FUNC key repeatedly):

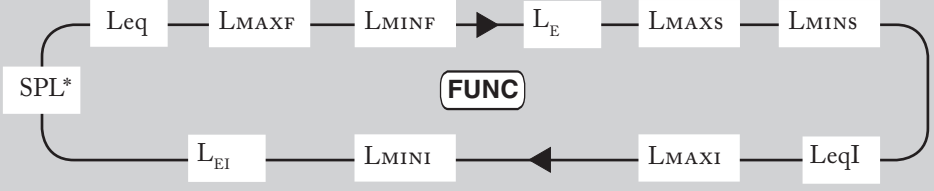


*Accessible during measurement only – not after!

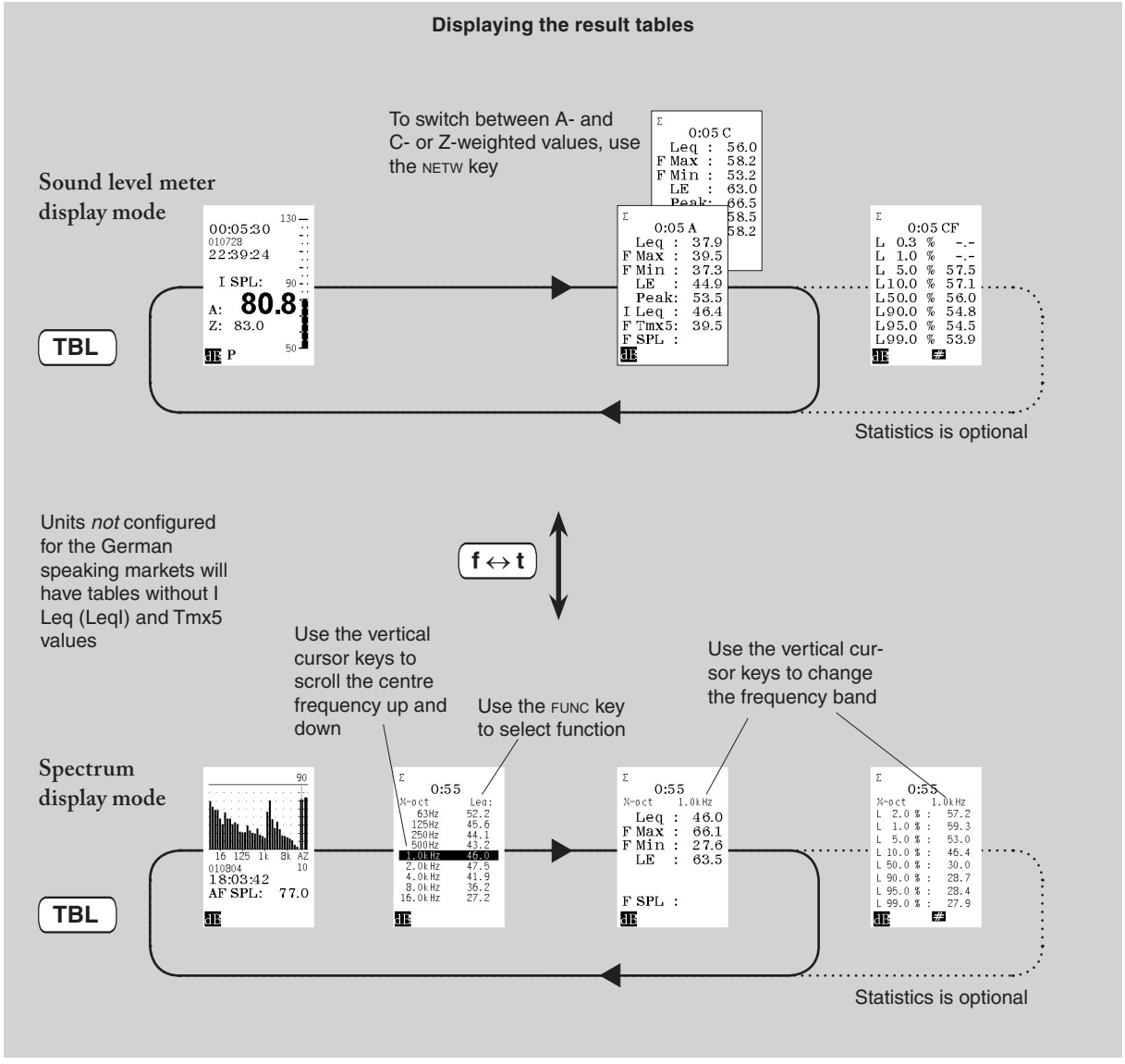
Units equipped with multiple time constants

Units equipped with multiple time constants will measure SPL, LMAX and LMIN with all three time constants (F, S, I)employed simultaneously. In sound level meter display mode, use the FUNC key to produce the function and then TC key to display values with the different time constants.

In the frequency spectrum display mode the functions will appear in the following sequence:



*Accessible during measurement only – not after!


Displaying the result tables
To switch between A- and C- or Z-weighted values, use the NETW key
Sound level meter display mode
TBL
Statistics is optional
Units *not* configured for the German speaking markets will have tables without I Leq (Leql) and Tmx5 values
f ↔ t
Use the vertical cursor keys to scroll the centre frequency up and down
Use the FUNC key to select function
Use the vertical cursor keys to change the frequency band
Spectrum display mode
TBL
Statistics is optional

Your user-editable percentile can be set to anything in the range 0.1–99.9 %, both extremes included.

Data measured, but not yet stored may be subject to changes in the user-defined percentile. This means that as long as you have not stored the acquired data, you may change the percentile as many times as you want, but once the data are stored any changing of the user-editable percentile is no longer possible.

How to set the user-editable percentile is described in the side bar on the previous page.

Missing percentiles? There may be percentiles that fail to produce values in the table. This is because you have not measured for a time long enough to provide the necessary number of samples.

Statistical sampling – which should not be confused with the sampling of the analogue-to-digital conversion – takes place 10 times a second. For comparison, the sampling of the analogue-to-digital conversion runs at 48 kHz!

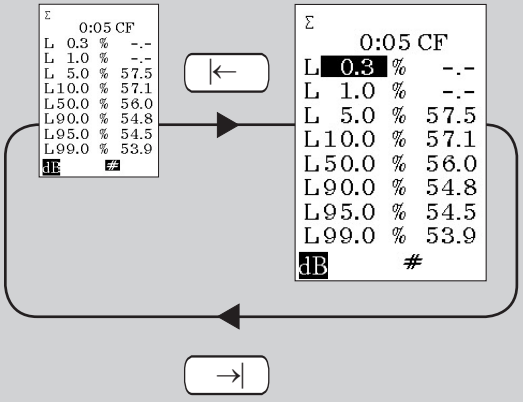
Since the statistical sampling takes place 10 times a second, it will take 10 seconds to produce 100 samples. You will need at least 100 samples to be able to calculate the 1% percentile.

Likewise, for the 0.1% percentile the minimum time required will be 100 seconds. Measurements whose duration are shorter than these minimum limits will not produce percentile values for all possible settings of the percentiles.

Editing the user-defined percentile

To enable the editing, the instrument must display the percentiles table. In the percentiles table press the |← key (the END-LEFT key) to enable this.
Once the percentile field is shown inverted (with white text on black background) the text can be edited using the NUMERICAL KEYPAD or INC and DEC. If you use the NUMERICAL KEYPAD you must press ENTER to confirm that you have keyed in the new percentile.

To terminate the editing process press the →| (end-right key). The corresponding percentile value will now be displayed, given that the measurement duration was long enough to provide a sufficent number of samples. Using ENTER will not work here.



The user-defined setting applies to every frequency band. They cannot have individual settings!

Storing the acquired data

The Nor118 has a large, non-volatile memory to hold the measurements. The memory structure resembles the memory structure of a personal computer in the sense that both use folders and files.

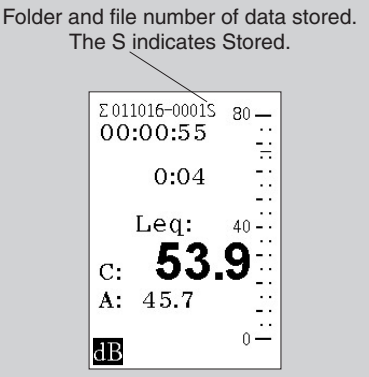
The structure of the Nor118 is very simple, the folder has the name of today's date and the files are numbered consecutively from 0001 and upwards. This means, of course, that the maximum number of measurements per day is 9998, but this should be a limitation most people will be able to live with. After all, you are going to look through these files later as well, aren't you?

Storing the acquired data:

- Press the STORE key. The display will show the folder and file number as can be seen from the Fig. below.

All aspects of the memory handling are discussed in detail in *Memory handling.*

When data are stored



Printing out the results

By connecting a printer to the RS232 interface, the results can be output to a printer. This is treated in detail in *Making hardcopies.*

Basic time profile measurements

Instruments equipped with the optional extension 6, level vs. time will be able to log the time profile like the classic level recorders used to do.

The time profile is measured by dividing a measurement into smaller periods of time, all having the same duration. Extension 6 allows the period length to be from 1 second and upwards in 1 second steps, while the *enhanced profile* (the optional extension 7) allows a period length from 100 ms and upwards in 25 ms steps (but in 1 second steps above 1 second period length).

The L_{eq} is measured for every period separately and stored in a buffer. Likewise, the L_{MAX} and L_{MIN} and the L_{PEAK} are measured for every period. All functions are A-weighted apart from the peak level which can be set as C-or Z-weighted. The enhanced profile (ext. 7) provides more options – see *Enhanced profile measurements*.

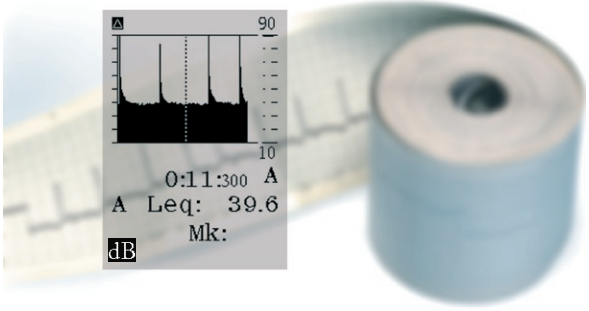
Profile measurements may be made in parallel with global frequency analysis (filters are optional) and in parallel with the traditional sound level measurement described in the chapter *Simple sound measurements*. If your Nor118 is

Global vs. profile

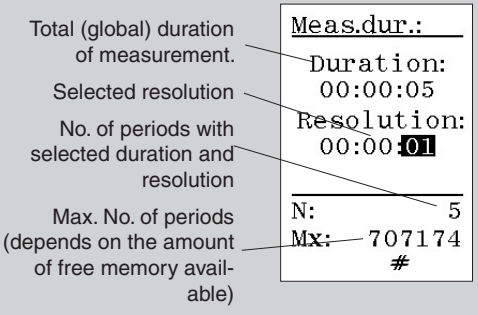
The traditional sound level measurement and the frequency analysis both consider the entire measurement as a whole without dividing it into smaller parts. One may therefore consider these two measurements as *global* measurements, while the level vs. time measurements represent the *profile*.

In the display the global measurements are denoted Σ (pronounced *sigma*) while the profile measurements are denoted Δ (pronounced *delta*). To switch between the modes, just press the Σ↔Δ key.

The time profile is no less than an electronic level recorder!



The measurement duration setup menu



The profile resolution does not have to be selected so that the global duration becomes a multiple of the profile resolution. The last period will be truncated if the duration divided by the profile is not an integer.

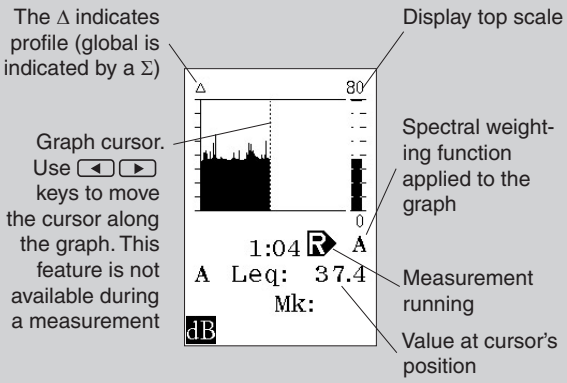
Which resolution should you use?

This will always be a trade-off between the need for information and the amount of data generated. You should also take into consideration the global duration of your measurement.

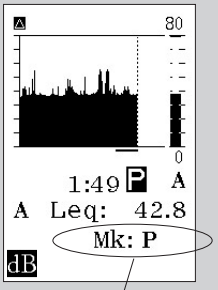
For example, you may want a higher resolution in a 1 minute measurement than in a 24 hour measurement. Will you need a 1 second resolution for 24 hours? It's going to be a lot of information to go through afterwards.

No absolute rules or guidelines can be given since there are so many different applications and requirements. However, we address the issue to remind you of the need to consider it when setting up for profile measurements.

The time profile display

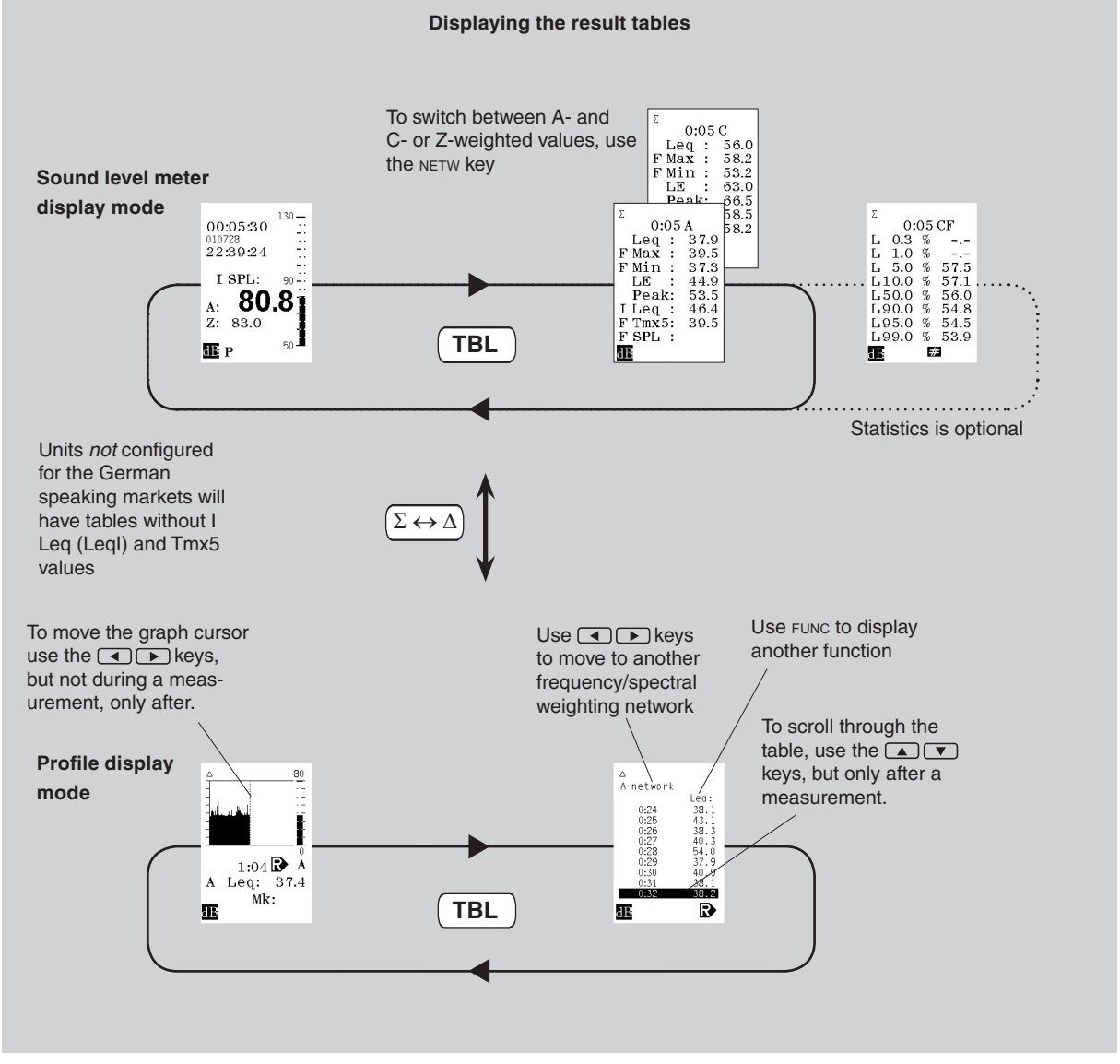


Pause and profile



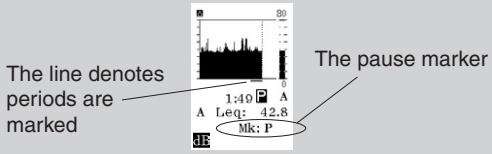
Here, the instrument is in pause mode. Global acquisition is halted, but the profile is still acquiring data. The thin line below the graph represents a marker associated with the periods acquired while paused. The meaning of the line below the graph is given by the text: Mk: P which should be interpreted as Marker: Paused to indicate that these data will not be a part of the global level assessment.

Displaying the result tables



No back-erase in profile pause mode. The resumption of a paused measurement will cause the ten seconds acquired immediately before the pause to be erased. This applies to the global measurement, but *not* to the profile.

Assume you have set up the measurement to also include profile and that the measurement is running. If you press PAUSE, the global data acquisition will be halted, but the profile will still acquire data! These data will be marked P for pause to denote that they were acquired in pause mode and that they do not participate in the global level assessments.



When you later press PAUSE again to resume, the amount of periods marked as paused will be expanded backwards in time to include periods acquired in the time-span subject to back-erasure in the global mode.

The reason why we designed it this way, was to provide you with the complete overview – if you later transfer the acquired data to your PC you will be able to do calculations on any parts of the profile while at the same time you'll be able to see the intervals that didn't take part in the global assessments.

Consequently, the duration of the measurement will seem ambigous. The global duration will be less the pause and less any back-erase, while the profile will have a duration including the pause length and without back-erase!

equipped with the multispectrum extension, you may even log the spectrum as a function of time! See the chapter *Multispectral measurements* for more on this.

This chapter deals with profile measurements only. For details on global frequency analysis see the chapter *Frequency analysis*.

Making measurements

All you need to do to set up the Nor118 to expand the measurements to also include the time profile is to define the time resolution.

To define the duration and the resolution:

1. Press SETUP > 2. Units with the option 6 installed will then produce the measurement duration menu. See side bar for details.
2. Set the global duration.
3. Move down to resolution and set as required. Navigate and leave the menu as usual.

If you've set up a profile resolution different from (i.e.

The effect of pressing STOP before resuming. If you terminate an ongoing measurement prematurely by pressing the STOP key and later resume the measurement by pressing PAUSE/CONT an S marker will be added to the period within which the PAUSE/CONT key was pressed – i.e. we mark out the first period after resumption.

shorter than) the global measurement duration, the instrument will log the time profile in addition to the global measurement.

To start the time profile measurement:

- Press START.

To switch to see the time profile:

- Press the Σ↔Δ key. To return to global mode press the key again.

Since the profile is an add-on to the global, the features available while measuring – described in the chapters *Simple sound measurements* and *Frequency analysis* apply even here.

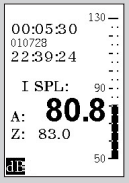
Functions measured in the basic time profile mode. In the basic time profile mode, the instrument logs the A-weighted equivalenmt level, the A-weighted maximum sound pressure level and the Z- or C-weighted peak level.

At the same time, the global mode measures the instantaneous SPL, the maximum and the minimum SPL, the equivalent level, the sound exposure level and the maximum peak level. All the global levels are measured as A-weighted and Z- or C-weighted levels.

Presenting the L(t) as a table

Numerical presentation of the acquired data works even here. Press TBL while in Δ (profile) mode to produce the table. This can be done during as well as after a measurement. An example of the table is shown in a side bar on the preceding pages. Use ▲ ▼ keys to move the cursor up and down, but only after the measurement has ended.

Combining multiple time constants with the basic time profile. Combining multiple time constants with basic time profile gives you no extra features in the profile logging. The function subject to the use of time constants – the maximum SPL will be logged with the time constant used in the normal display mode by the time you start the measurement.



In the above example this will be the I time constant. Note that statistics (if applicable) will still make use of the f time constant and that the other functions logged in the profile part of the measurement make no use of time constants.

The global part of the measurement will utilise the multiple time constant as any global measurement will – see *Simple sound measurements* for details.

Enhanced time profile measurements

The optional extension 7 – enhanced time profile lets you select the functions to be measured as a function of time. Select from A-weighted functions as well as C- or Z-weighted – even A-weighted peak! Furthermore, enhanced profile opens up for the use of source coding – see *Adding markers* for details. Apart from this there is no difference between basic and enhanced time profile mode.

Selecting which functions to log

We always recommend that you keep the number of functions to measure as small as possible. This helps to maintain the overview and keeps the amount of memory spent low. Although it may be tempting to measure "everything", do not forget that you are going to review the acquired data afterwards. How much time are you willing to devote to that?

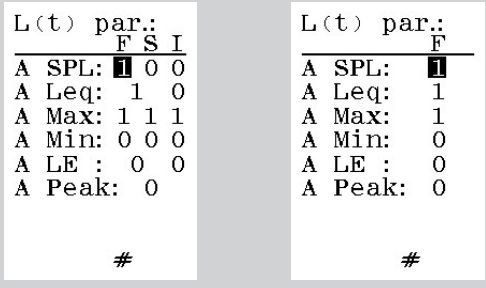
Setting up the functions to log:

1 To gain access to the profile function activation menu, press SETUP > 3 [L(t) PAR.] . This menu looks as shown to the right.

2 Navigate in the menu as usual and use the INC and DEC keys to activate the functions required for your task. Deactivate those that you won't need. A 1 means activated and a 0 means deactivated.

3 Both the A-weighted and the C- or Z-weighted functions are accessible from within this menu. Use the NETW key to switch between A- and C- or Z-weighted (which is set up in the 2nd network menu – see *Simple sound measurements* for more on this.

Functions to log – setup menu



Setup menu with multiple time constant option (left) and without the multiple time constant option (right)

Units with multiple time constants installed may include the time constant setting in the setup – see the Fig. below left.

Functions like L_{eq}, L_{MAX}, L_{MIN} and L_{PEAK} are measured during each period. The SPL, however, is sampled at the end of each period.

Copy the setting to Prnt/Xfer

Upon leaving the functions to log menu you will be prompted to decide whether the settings you made shall apply to the functions to print or transfer

In order to avoid being totally drowned in values, you may set up instrument to just print a few of the functions measured. However, for convenience we offer the feature of setting up the same functions for printing as for measurement. If you then want to print fewer functions, just go to the print functions setup menu and deactivate those you won't need.

To produce the print functions setup menu:

- Press SETUP > 1 > 8

Functions to be printed are denoted by a 1.

The time constant cannot be set from inside the L(t) par menu! Instruments which are not equipped with multiple time constants will make use of the time constant currently selected. If this is not the one you want to use for your profile measurements, you must change it. This cannot be done from within the L(t) par menu. Leave the menu and change the time constant by means of the TC key.

The same applies to the transfer of measured function values to your PC. You may not want to have all the data transferred, so you can set up which functions whose values you want to transfer.

To produce the transfer functions setup menu:

- Press SETUP > 1 > 9

Setting the resolution

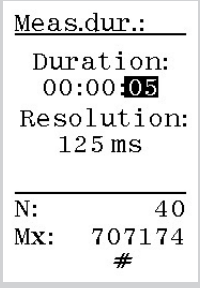
To define the duration and the resolution:

1. Press SETUP > 2. Units with the option 7 installed will then produce the measurement duration menu. See side bar for details.

2. Set the global duration.

3. Move down to resolution and set as required. Navigate and leave the menu as usual.

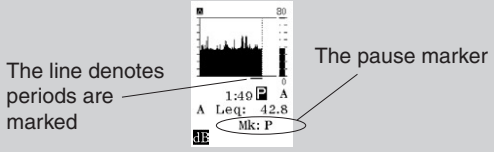
Option 7 permits the time resolution to be as good as 100 ms. See text for details



Here the resolution is set to 125 ms

No back erase in profile pause mode. The resumption of a paused measurement will cause the ten seconds acquired immediately before the pause to be erased. This applies to the global measurement, but not to the profile.

Assume you have set up the measurement to also include profile and that the measurement is running. If you press PAUSE, the global data acquisition will be halted, but the profile will still acquire data! These data will be marked P for pause to denote that they were acquired in pause mode and that they do not participate in the global level assessments.



When you later press PAUSE again to resume, the amount of periods marked as paused will be expanded backwards in time to include periods acquired in the time-span subject to back-erasure in the global mode.

The reason why we designed it this way, was to provide you with the complete overview – if you later transfer the acquired data to your PC you will be able to do calculations on any parts of the profile while at the same time you'll be able to see the intervals that didn't take part in the global assessments.

Consequently, the duration of the measurement will seem ambigous. The global duration will be less the pause and less any back-erase, while the profile will have a duration including the pause length and without back-erase.

If you've set up a profile resolution different from (i.e. shorter than) the global measurement duration, the instrument will log the time profile in addition to the global measurement.

The enhanced profile offers a time resolution (period length) down to 100 ms! Between 100 ms and 1 s the resolution is adjustable in 25 ms steps. Above 1 s the step size is 1 s as is the case for the basic profile.

Setting a period length better than a second

- Set the resolution to 1 s and press the DEC key to enter the ms area. Scroll down to the required setting or use the NUMERICAL KEYPAD as usual after the ms sign appears. Note that if you keep the DEC key (or the INC key) depressed it will, after a while, speed up the scrolling.

or

- Key in 59 s as the resolution and then press enter followed by INC, the resolution will be set to 100 ms immediately. Press INC or DEC to adjust, or use the NUMERICAL KEYPAD to set the value directly. Step size is 25 ms. If you key in a value between the valid settings the value will be put to the nearest valid setting.

The effect of pressing STOP before resuming. If you terminate an ongoing measurement prematurely by pressing the STOP key and later resume the measurement by pressing PAUSE/CONT an s marker will be added to the period within which the PAUSE/CONT key was pressed – i.e. we mark out the first period after resumption.

Measuring in enhanced mode

The enhanced time profile mode is similar to the basic time mode and should thus be regarded as an add-on to the instrument's basic functionality. This means that the features available while measuring – described in the chapters *Simple sound measurements* and *Frequency analysis* apply even here.

Displaying the functions measured

To see the different functions measured, just use the FUNC key as usual.

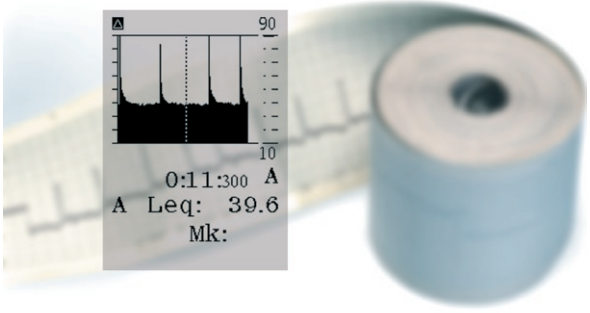
Presenting the L(t) as a table

Numerical presentation of the acquired data works even here. Press TBL while in Δ (profile) mode to produce the table. This can be done during as well as after a measurement. An example of the table is shown to the left. Use ▲ ▼ keys to move the cursor up and down, but only after the measurement has ended.

Adding markers to a measurement

Have you ever made a measurement where you later found out that you desperately need to know what caused the level to be what it turned out to be?

What were these impulses caused by?



Enter *source coding*. With the enhanced profile option (optional extension 7) you may tag or code sources as they happen. A one digit code (which appears in the display as 1~4) is entered to later serve as an identification of the type of noise. This can also be referred to as adding a marker to the measurement.

Example: In a traffic noise measurement a bus passing may be identified by the digit "1", while trucks may be identified by "2", unexpected vehicles by "3" etc.

In the profile display the markers appear as dots or lines below the graph. If you move the time cursor onto such a dot, the marker type (i.e. its number) will appear in the display.

During a measurement, adding any of the markers 1, 2 and 3 will assign the corresponding marker number to the current period only.

Adding marker number 4, however, will assign this marker to the current period plus all consecutive periods until the marker again is deactivated. This marker type is often referred to as a toggle marker, as opposed to the single marker which is the other type. A typical application for a toggle marker is to mark out intervals of particular interest.

The keys to use

The keys used to enter the markers are CAL (marker 1), PRINT (marker 2), EXIT (marker 3) and ENTER (marker 4) since these keys are the lower most keys of the front panel and thus easy to reach during a measurement. None of these keys are used for other things during a measurement either.

Other markers inserted by the instrument

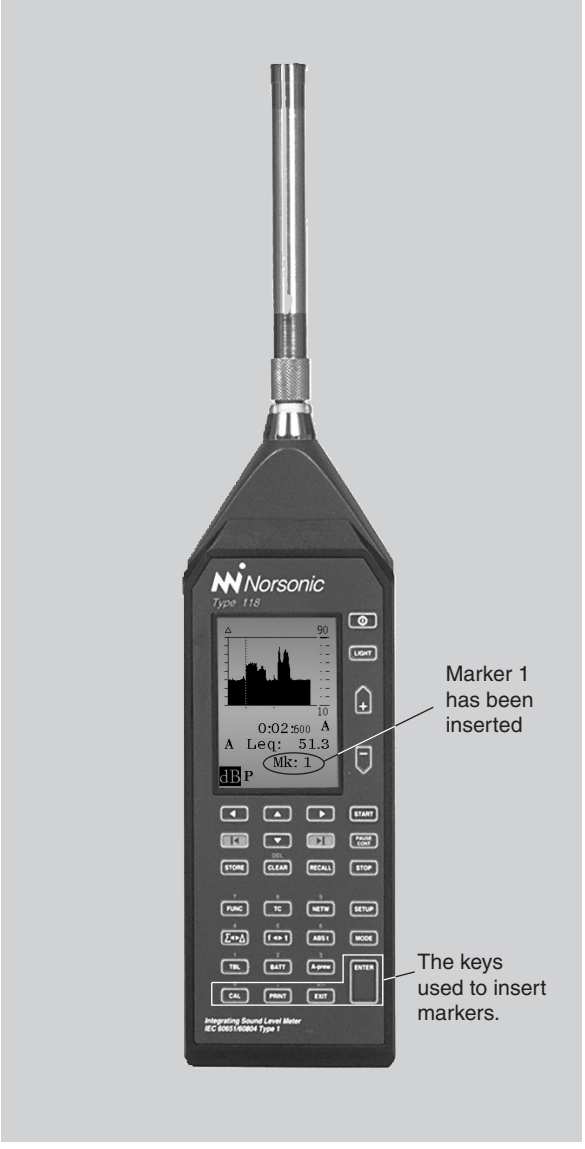
As discussed in the side bar *No back-erase in profile mode* (a few pages back) the marker P is added to the periods to denote that these periods contain data acquired in pause mode.

In addition, if you terminate an ongoing measurement prematurely by pressing the STOP key and later resume the measurement by pressing PAUSE/CONT an S marker will be added to the period within which the PAUSE/CONT key was pressed – i.e. we mark out the first period after resumption.

P and S markers have priority

The marker 4 is a *toggle* marker, i.e. once activated it will assign a marker to every period occurring until it is deactivated again.

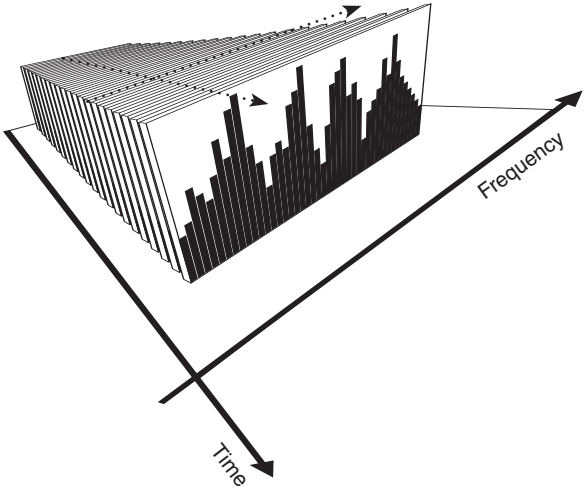
What happens if marker 4 has been activated while you press the STOP key or the PAUSE key? Will it assign both 4 and P or S? No, it won't! P and S have priority and they will be inserted instead of any other marker active by the time PAUSE or STOP is pressed. So you'll never have more than one marker assigned to a profile period.



Multispectrum measurements

The optional extension 8 takes the instrument further along the axis of sophistication by introducing multispectrum measurements.

This upgrade of time profile permits complete spectra to be measured as a function of time – not just broadband values (albeit spectrally weighted). You may then track a given frequency band as a function of time or inspect the spectrum at a given moment in time. This is illustrated by the dotted lines in the below Fig.



Setting up for multispectrum

Multispectrum measurements can be made based on basic- as well as enhanced time profile extensions installed.

Units equipped with basic profile extension

Units equipped with basic time profile extension (and filters, of course), have a very simple setup procedure:

To set up for multispectrum measurements (basic time profile):

1. Set up the instrument to make time profile measurements as described in *Basic time profile measurements.*

2. Press setup > 4 and activate the filters as described in the chapter *Frequency analysis.* Navigate, set the parameters and leave the menu in the usual manner.

The instrument is now ready to make multispectrum measurements

Units equipped with enhanced profile extension

Instruments with enhanced time profile extension installed, have a few more things to set.

To set up for multispectrum measurements (enhanced time profile):

1 Set up the duration and resolution

2 To gain access to the profile function activation menu, press SETUP > 3 [L(t) Par.] . This menu looks as shown below.

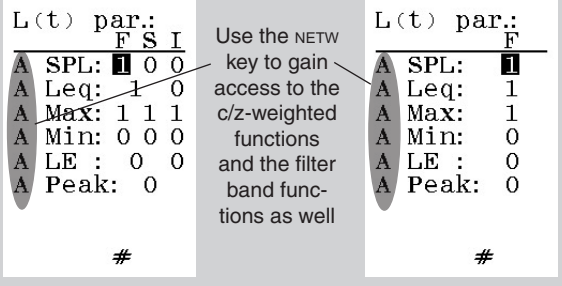
3 Navigate in the menu as usual and use the INC and DEC keys to activate the functions required for your task. Deactivate those that you won't need. A 1 means activated and a 0 means deactivated.

This menu is used to activate/deactivate:

- the A-weighted functions to be measured
- the C- or Z-weighted functions to be measured
- the filter band functions to be measured

Use the NETW key to switch between A-weighted functions, the C-/Z-weighted functions *and* the filter band functions.

Functions to log – setup menu



Setup menu with multiple time constant option (left) and without the multiple time constant option (right)

If you fail to activate functions for the filter bands, there will be no multispectrum data, either.

Making multispectrum measurements

Multispectrum measurements are made in the same way as ordinary time profile measurements. The only difference lies in the fact that the multispectrum measurements log the spectrum as a function of time and not just the broadband values.

To go between level vs. time and level vs. frequency:

1 Make sure the instrument is in profile mode (a Δ displayed in the upper left corner of the display). If not, press the Σ↔Δ key to enter profile mode.

2 Use the f↔t key to go between display of level vs. time and level vs. frequency.

To move the cursor along the frequency axis:

1 Make sure the display shows the spectrum. If needed, use the f↔t key.

2 Use the ← and the → keys to move the cursor along the frequency axis.

3 Use the |← and the →| keys to move the cursor to either extremes of the spectrum.

Are you going to use c or z-weighting as spectral weighting function? This is set up in the 2nd network menu – press SETUP >1 (Instr.) >5 (2nd netw) and navigate as usual.

To move the cursor along the time profile axis:

1 Make sure the display shows the time profile (level vs. time). If needed, use the f↔t key.

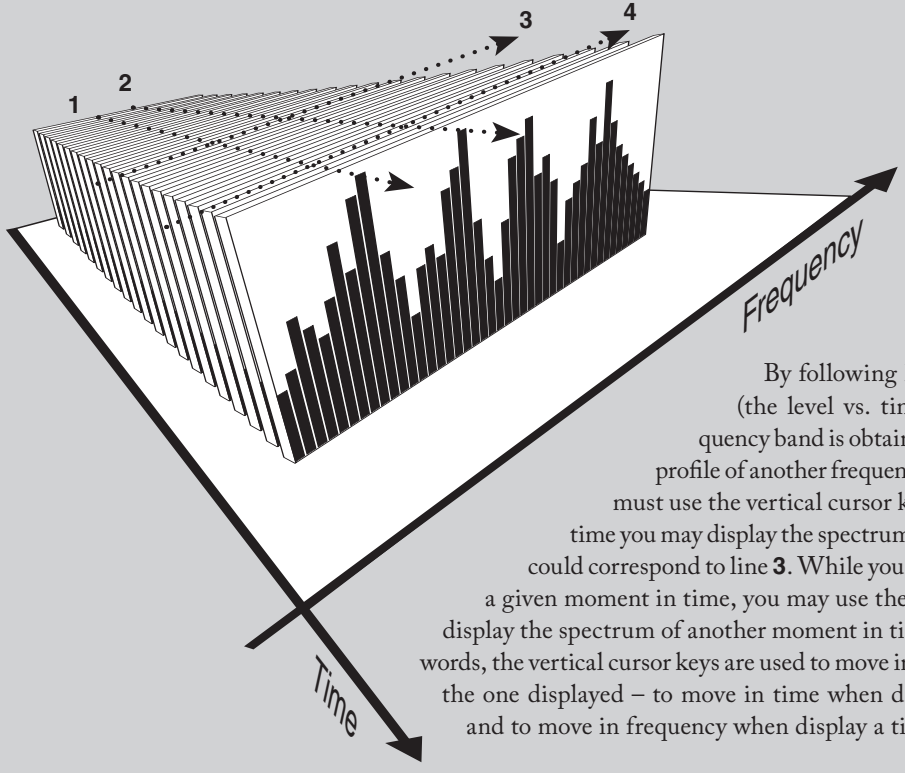
2 Use the ← and the → keys to move the cursor along the time axis.

3 Use the |← and the →| keys to move the cursor one screenwidth along the time axis in either direction.

To see the spectrum of another moment in time:

1 Make sure the instrument is in profile mode and that the spectrum is displayed (a Δ displayed in the upper left corner of the display). If not, press the Σ↔Δ key to enter profile mode and the f↔t key to enter the frequency domain.

2 Use the ↑ and the ↓ keys (repeatedly, if needed) to reach the moment in time required.



By following line **1**, the time profile (the level vs. time) of one specific frequency band is obtained. To display the time profile of another frequency band (e.g. line **2**) you must use the vertical cursor keys. At any moment in time you may display the spectrum (use the f↔t key). This could correspond to line **3**. While you display the spectrum at a given moment in time, you may use the vertical cursor keys to display the spectrum of another moment in time, e.g. line **4**. In other words, the vertical cursor keys are used to move in the other domain than the one displayed – to move in time when displaying the spectrum and to move in frequency when display a time profile.

To see the level vs. time (the profile) graph of another frequency band:

1 Make sure the display shows a time profile (level vs. time). Use the f↔t key, if needed.

2 Use the ↑ and the ↓ keys (repeatedly, if needed) to move to another frequency band.

To see the global values:

1 Make sure the instrument is in global mode (a Σ displayed in the upper left corner of the display). If not, press the Σ↔Δ key to enter global mode.

2 Use the f↔t key to go between the sound level meter display and the spectrum display. Move the spectrum cursor as explained above.

The spectrum you see now is the global spectrum. This spectrum should not be confused with the multispectrum feature.

The result tables

The measured values can be presented tabulated as usual. In multispectrum mode there are two tables available in profile mode:

- Each function shown for all frequency bands (use the FUNC key to go to another function)
- The functions measured shown for a single frequency band or spectral weighting network.

These are shown in the Fig. to the right as well as overleaf together with the displays and tables available for the global part of the measurement.

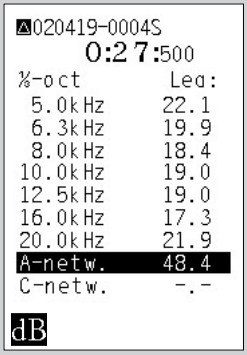
To produce the result tables in multispectrum mode:

1 Press TBL once to produce Table 1 and again to produce Table 2.

2 Press again to return to graphical display.

The key pressing sequence is also illustrated in the Fig. overleaf, while operating details are provided below.

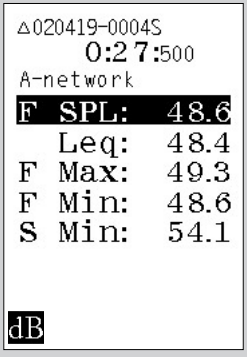
Table 1

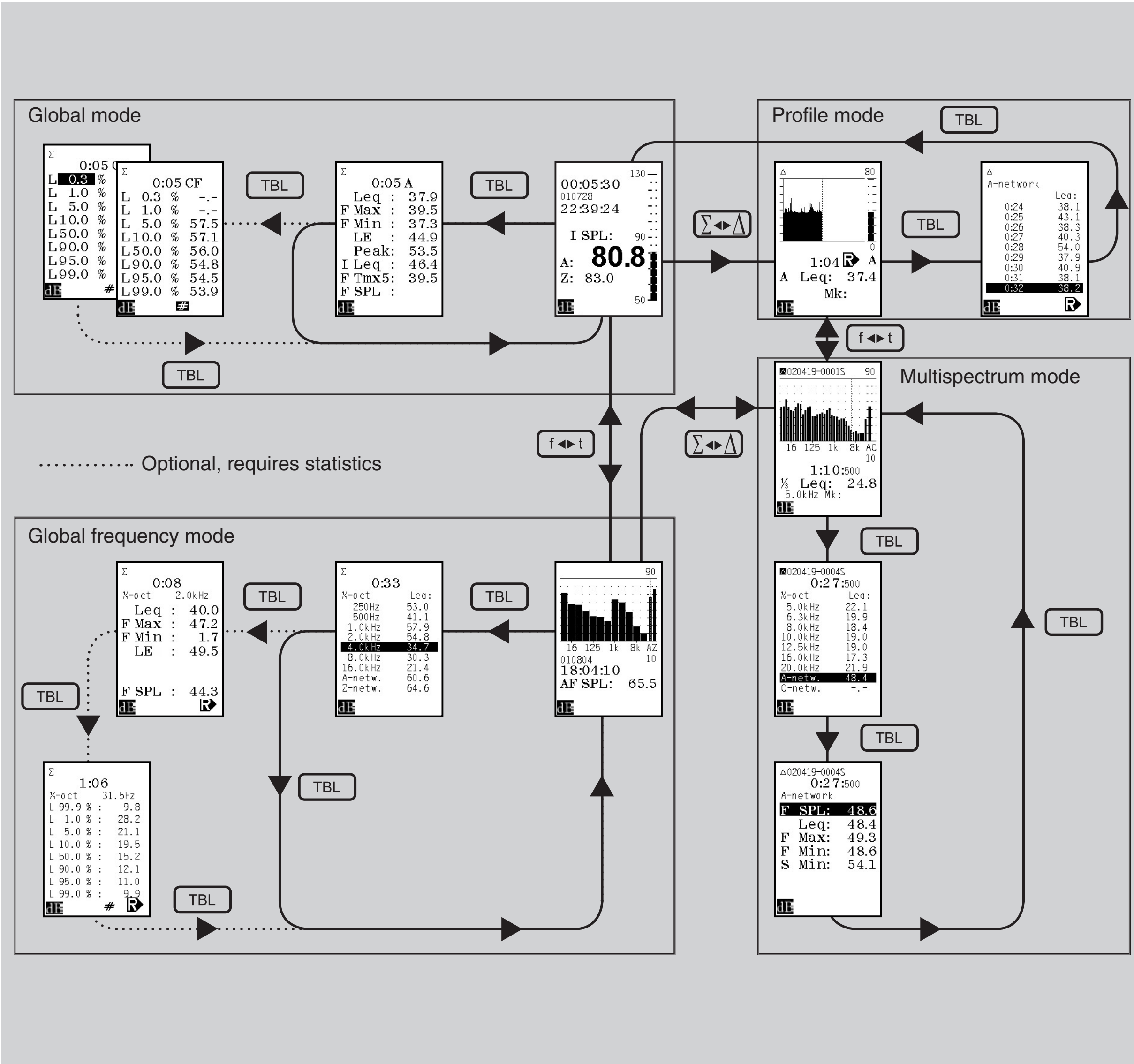


Use ▲ ▼ keys to move up and down in table, ◄ ► keys to move to another moment in time and FUNC to scroll through the functions measured.

Use ▲ ▼ keys to move up and down in frequency (incl. spectral weighting networks) and ◄ ► keys to move to another moment in time and FUNC to scroll through the functions measured.

Table 2




Global mode
Profile mode
Multispectrum mode
Global frequency mode
TBL
Σ◂▸Δ
f◂▸t
Optional, requires statistics

Both tables are accessible during measurement, you can even start a measurement from within any of the tables! All functions available for a profile measurement apply even here. If your instrument supports the use of markers, they may be used in the usual way. Pause and global back-erasure also works as usual. For a discussion of these features, turn to *Basic time profile measurements*, *Enhanced time profile measurements* and *Adding markers to a measurement*.

Reverberation time measurements

The optional extension 9 for the Nor118 permits measurements of the reverberation time. If your instrument is equipped with filters, the reverberation time is measured in every frequency band. Units without filters will calculate the reverberation time employing the spectral weighting circuitss only (A- and C- or Z-weighted results).

The calculation algorithm used complies with the requirements set by the ISO 354 Acoustics – Measurement of sound absorption in a reverberation room, in its latest revision and the ISO 3382 Acoustics – Measurements of the reverberation time of rooms with reference to other acoustical parameters.

What is reverberation time?

Assume that you switch on a sound source in a room equipped with a microphone system. You will note that the sound level will not reach a steady level immediately. The reason why is that the sound will consist of the direct sound radiating from the source in combination with reflected sound and these reflections take time before they reach the microphone.

Once the steady state condition is reached, the level wil increase no further. If you now switch off the sound source, the sound will take some time to decay. The time it takes for the sound pressure to decay by 60 dB is called the *reverberation time*.

Excitation signals

Above we talked about having a steady sound source in a room when measuring the reverberation time. However, we may just as well use an impulse as excitation source. This impulse may be generated by a pistol, an exploding paper bag or any other impulsive sound source capable of creating enough sound energy in the frequency range we need.

Speaking of paper bags, the primary application of paper bags will normally be to produce low frequency energy in a frequency range where pistols tend to have too little acoustic energy. On the other hand, the high frequency energy produced by an exploding paper bag is not impressive, so you cannot rely on a paper bag alone.

Impulse excitation eliminates the need for dragging heavy loudspeaker/amplifier combinations with you.

In addition you will be able to rely on battery operation alone with no need for mains voltage. This will increase your field operation capabilities.

How we measure the reverberation time

Although the reverberation time is defined as the time it takes for the sound level in a room to decay by 60 dB, the presence of background noise will indeed make this difficult to measure. The normal circumvention is then to measure decays of 20 or 30 dB and then extrapolate the results to 60 dB. In the Nor118 a 20 dB range is used and the figures are then normalised to 60 dB. Reverberation times measured this way are often denoted T20.

Backward integration

The instrument employs what is called the INTEGRATED IMPULSE RESPONSE METHOD or SCHROEDER METHOD to calculate the decay.

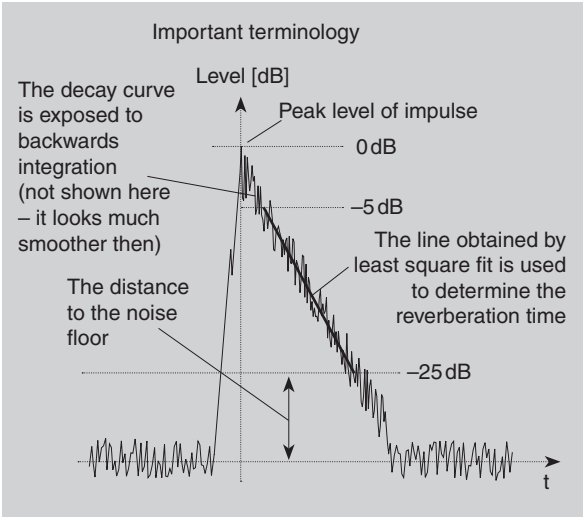
The excitation signal used is, by nature, a stochastic signal and repeated excitation will yield different decay curves each time you do this.

However, if you do this a large number of times, the decays will cluster around a mean value. Dr. Manfred Schroeder has shown that this value can be obtained using a single decay measurement only. Two restrictions apply here; impulse excitation must be used (hence noise source excitation is out of the question) and the decay must be integrated backwards with respect to the time.

The Nor118 does this by default (in fact you cannot switch the feature off). This means that you will immediately obtain the expected value (in the statistical sense of the word) of the decay. Observe though that this will not free you from spatial averaging. You must always pay respect to the fact that local variations exist in all rooms. The position chosen for the microphone is not necessarily fully representative for the room. You should always make several measurements and average them – see later in this chapter for more on this.

Least square fit

Let us now consider the reverberation decay as a set of experimentally observed points. The method of LEAST SQUARE FIT is then used to find the line of best fit that one for which the sum of squares of the deviations between the line and the observed points is a minimum. This method is used in the Nor118 to obtain a line representing the reverberation time – see Fig. below.



When measuring the reverberation time, we specify a trigger level above which a sound level occurring is assumed to be the excitation impulse. The instrument captures the decay, looks for the peak value and starts the calculation 5 dB below this value. Then it measures the time it takes for sound to decay by 20 dB (by means of the LEAST SQUARE FIT METHOD) and multiplies the value found by 3. If the distance to the noise floor is more than 10 dB and if the reverberation times are more than a specified set of minimum values and finally, if no overload has occurred, the values are presented as valid.

Minimum reverberation times possible

Nothing changes infinitely fast in nature. It will always take some time to determine the level in each frequency band with sufficient accuracy. This is related to the BT product (BANDWIDTH × MEASUREMENT TIME) which states that the narrower the bandwidth, the longer time it takes to determine the level at a given standard deviation.

Likewise, the filters are not cleared instantly if the input signal is removed suddenly. Instead, they have a finite decay, which may be considered as a virtual reverberation time. The narrower the filter is, the longer this virtual reverberation time will be.

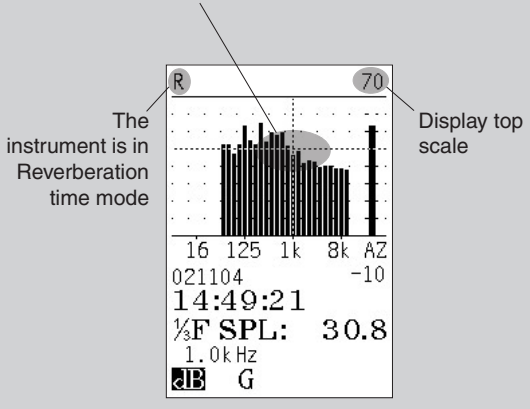
The minimum reverberation times for the Nor118 are listed in the table to the right. If reverberation times shorter than those listed in the table are encountered or the minimum distance to the noise floor is violated, the instrument will produce a ? in the reverberation time table to indicate this.

On the other hand, the maximum reverberation time possible to measure is 8 seconds in the Nor118.

Minimum reverberation times

Frequency	Third-octaves	Octaves
	[sec]	[sec]
50 Hz	1.01	
63 Hz	0.83	0.43
80 Hz	0.68	
100 Hz	0.56	
125 Hz	0.46	0.23
160 Hz	0.38	
200 Hz	0.31	
250 Hz	0.26	0.13
315 Hz	0.21	
400 Hz	0.17	
500 Hz	0.14	0.07
630 Hz	0.12	
800 Hz	0.10	
1 kHz	0.08	0.04
1.25 kHz	0.06	
1.6 kHz	0.05	
2 kHz	0.04	0.02
2.5 kHz	0.04	
3.15 kHz	0.03	
4 kHz	0.02	0.02
5 kHz	0.02	
6.3 kHz	0.02	
8 kHz	0.02	0.02
10 kHz	0.02	
A	0.09	0.09
C	0.12	0.12
Z	TBD	TBD

The level above which trigger will take place (provided that a level transition takes place) is shown as a horizontal line. This line is always located 30 dB below the display top scale. To "move" the line up and down (what you do is to change the display top scale) use the + and – keys. The position of the graph cursor (the frequency cursor) determines the frequency band to be used as trigger band.



Making reverberation measurements

Setup of the Nor118 for reverberation time measurements is really simple. There is no range or duration setting, all you need to do is to set the trigger level.

To set up for reverberation time measurements:

1 Press MODE > 2 (Rev) to enter reverberation time mode. The display will now look as shown above.

2 If needed, set the filter bandwidth to ¹⁄₁ or ¹⁄₃ octave (requires that filters are installed – see the chapter *Frequency analysis* for details).

The **R** in the *upper left corner* of the display indicates that the instrument now is in reverberation time mode. By default, the cursor is located on the 1 kHz frequency band. The cursor position determines the frequency band used to trigger the measurement.

3 If 1 kHz is not suitable as trigger band (which may well be the case when using a paper bag as excitation source) use the CURSOR keys to move the cursor in the usual manner.

What is trigger? To start a measurement the instrument will need to have a trigger condition fulfilled. Sound analyseres designed to be used for a broad variety of applications need a set of trigger conditions to be versatile enough. Such conditions may include trigger by clock (start measuring at a predefined time of day), trigger when the level exceeds a certain predefined threshold, trigger on an external trigger signal occurring (e.g. a car passing a light barrier) etc.

A sound level meter albeit as sophisticated as the Nor118, normally provides only one trigger condition – the trigger on pressing START, often referred to as unconditional triggering.

However, reverberation time using external excitation sources will require a *trigger on level exceeds a predefined threshold* function so that the instrument knows when to start capturing the impulse and its decay. You will then have to define the level threshold above which the impulse is considered to be present and the frequency band in which to look for the impulse.

You will note a horizontal line located 30 dB below the displayed top scale. Remember that the displayed top scale is purely a display feature and not related to the measurement range setting.

This line represents the trigger level threshold for the impulse decay capture.

4 Use the + and – keys (the INC and DEC keys) to change the trigger level threshold in 10 dB steps, if applicable.

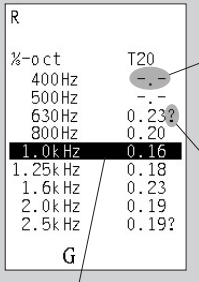
Reverberation time setups cannot be stored and there should be no need to either, since the only things to set up are the trigger frequency band and the trigger level threshold.

To make a reverberation time measurement:

- Press the START key and generate the impulse. While the instrument waits for the trigger condition to be fulfilled, a **W** (WAITING) is displayed. Once the instrument detects a level above the threshold in the frequency band you have specified, the capture of the impulse and its decay will begin. An **R** will appear in the display when the measurement is running.

Frequency bands above 10 kHz are not measured! Although the instrument has filters covering the frequency range up to 20kHz (expressed as filter band centre frequency), reverberation time calculations are made up to 10 kHz only. Those above are shown in the table as well, but no values are presented.

The reverberation times measured are presented tabulated and are all in seconds, as shown here.



Values missing are shown like this. Frequency bands not measured will look like this. The same applies to frequency bands where no value was obtainable.

If the background noise level is too high, or the calculated reverberation time is shorter than the limit (see side bar Minimum reverberation times for more on this) a question mark appears next to the dubious value(s).

Navigate in the table by using the ▲ ▼ keys to see values of other frequency bands.

Once you have pressed the START key the trigger setting cannot be changed, even if the measurement is not yet running. To be able to change these settings you must terminate the ongoing measurement.

To terminate an ongoing measurement:

- Press STOP or PAUSE/CONT. In both cases the instrument will return to READY mode.

The instrument will measure for 10 seconds and count down to 0 to indicate how much is left of the measurement. The acquired results are then presented as a table.

The table shows the calculated reverberation time for each frequency band and for the spectral weighting networks (A- and C- or Z-weighting). If the reverberation time measured is too short compared to the minimum

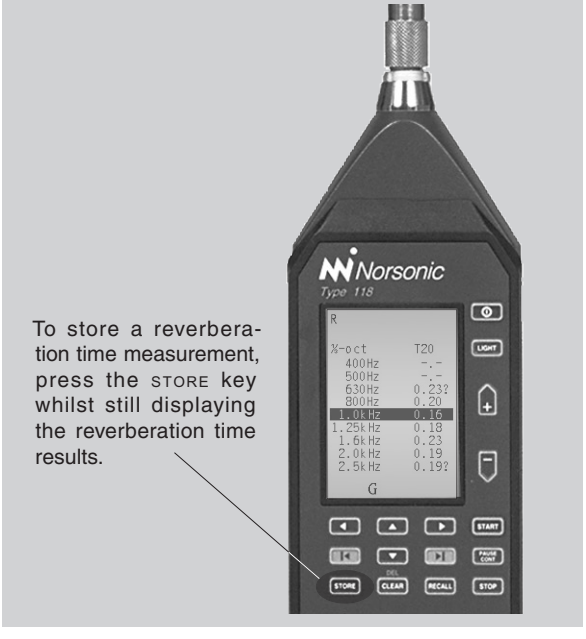
reverberation time stated in the table a few pages back a question mark will be shown to the right of the value.

Likewise, the question mark will appear if the background noise level is too high. All in all, the question mark tells you that the measurement is not reliable. However, it does not tell you why it is so.

Overload occurring during the impulse decay capture is indicated by an **OL** appearing above the result table. In addition, no reverberation time will be calculated and the table will reflect this.

Saving the measurement

While still displaying the result table the acquired data may easily be stored.



To store the acquired data:

- Press STORE to save the measurement. The measurement will be stored in a folder bearing today's date as its name and the file name will be the first free number. Existing files will not be over written. If the folder did not exist, it will be created when you store the data.

Recalling a stored measurement

A stored measurement is retrieved as any other measurement stored. The values will be presented in a table identical to the result table. See the chapter *Memory handling* for a discussion of storage and retrieval of measured data.

Making another measurement

If you want to make another measurement, you may do this with or without storing the one you just did.

To make another measurement:

- While in the result table, press the START key. You will now be prompted to either store the acquired data (by pressing STORE) or start another measurement directly (by pressing START again).

Leaving the table returning to READY mode

You may leave the table to go back to ready mode without having to start another measurement first. This may be the case if the trigger settings needs adjustment.

To leave the table:

- Press the EXIT key to leave the table. You will now be prompted to either store the acquired data (by pressing STORE) or exit directly (by pressing EXIT again).

About sound power measurements

Sound power may be calculated from sound pressure levels using the Nor118. The method is described in ISO 3476 acoustics – determination of sound power levels of noise sources – survey method and requires measurements of the A-weighted sound pressure level at four or more positions located on a hypothetical measurement surface of an area s which envelopes the source.

To facilitate the location of the microphone positions on the measurement surface a hypothetical reference box shall be defined. When defining the dimensions of this box, elements protruding from the source which are not significant radiators of sound energy may be disregarded.

The measurement surface on which the microphone positions lie envelopes the source as well as the reference box.

The location of the source under test, the measurement surface and the microphone positions are defined by a coordinate system with the horizontal axes x and y in the ground plane parallel to the length and width of the reference box. The characteristic dimension d_0 is shown in the Fig. on the next page.

One of the following two shapes shall be used for the measurement surface:

a a rectangular parallelepiped whose sides are parallel to those of the reference box; in this case the measurement distance d is the distance between the measurement surface and the reference box.

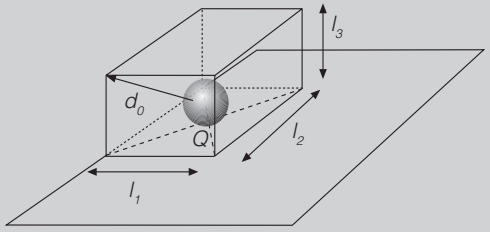
b a hemispherical surface or partial hemispherical surface of radius r;

For sources usually mounted and/or to be measured in rooms or spaces under unfavourable acoustical conditions (e.g. many reflecting objects and high levels of background noise), the selection of a small measurement distance is appropriate and usually dictates the selection of a *parallelepiped* measurement surface. For sources usually mounted and/or to be measured in large open areas under satisfactory acoustical conditions, a large measurement distance is usually selected and in this case the *hemispherical* measurement surface is preferred.

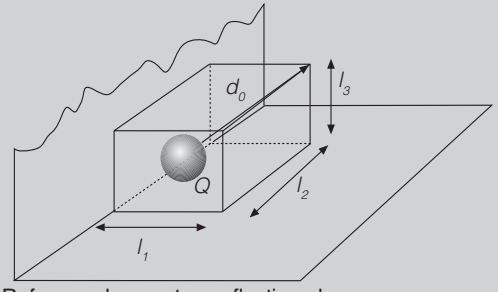
For measurements on a series of similar sources (e.g. machines of the same type or a given family of equipment), the use of the same shape of measurement surface is required.

A test report shall always be made and the construction of the reference box, the size and shape of the measurement surface, as well as the measurement distance d or the radius of the hemisphere r, shall be described in the test report.

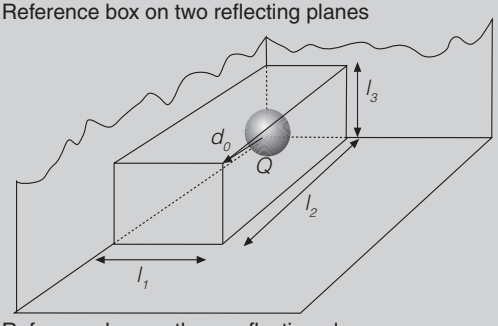
The Fig. shows the characteristic dimension d_o for the different locations of the source under test.



Reference box on one reflecting plane



Reference box on two reflecting planes



Reference box on three reflecting planes

Rectangular parallelepiped

For the rectangular parallelepiped reference box there exist three possible configurations as shown in the Fig to the left.

The characteristic dimension d_0 can be calculated from the following formulae:

Reference box on one reflecting plane:

$$d_0 = \sqrt{(\frac{l_1}{2})^2 + (\frac{l_2}{2})^2 + l_3^2}$$

Reference box on two reflecting planes:

$$d_0 = \sqrt{(\frac{l_1}{2})^2 + l_2^2 + l_3^2}$$

Reference box on three reflecting planes:

$$d_0 = \sqrt{l_1^2 + l_2^2 + l_3^2}$$

Hemispherical measurement surface

The hemisphere shall be centred in the middle of the box consisting of the reference box and its images in the adjoining reflecting planes, point Q in the Figs. overleaf. The radius r of the hemispherical measurement surface shall be equal to or greater than twice the characteristic source dimension d_0 and not less that 1 metre.

The radius of the hemisphere should be one of the

following values (in metres): 1, 2, 4, 6, 8, 10, 12, 14 or 16. Some of these radii may be too large to meet the environmental requirements given in ISO 3746. If so, such large values shall not be used.

The environmental requirements state that the reflecting plane must not be of such a material or in such a condition that it radiates any appreciable sound energy due to vibration. If the measurements are made outdoors over grass- or snow-covered ground, the measurement distance shall not exceed 1 metre. The general requirement is that the sound absorption coefficient of the reflecting plane shall be less than 0.1 over the frequency range of interest. Also no reflecting objects that are not part of the source under test shall be located inside the measurement surface.

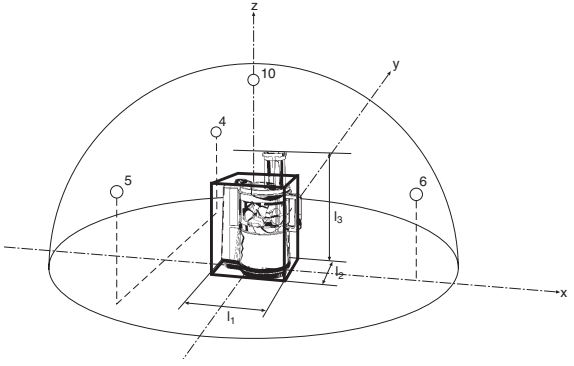
Hemispherical microphone positions

If there is only one reflecting plane, the microphone positions lie on the hypothetical hemispherical surface of area $S = 2\pi r^2$, enveloping the source and terminating on the reflecting plane. If the source under test is in front of a wall, $S = \pi r^2$ and if it is in a corner, $S = 0.5\pi r^2$.

The Fig. below left shows the location of four key microphone positions, each associated with equal areas on the surface of the hemisphere of radius r.

If a source is installed adjacent to more than one reflecting plane, the Figs. shown on the next page are used to define a suitable measurement surface and the microphone positions.

Microphone positions on a hemisphere – key microphone positions



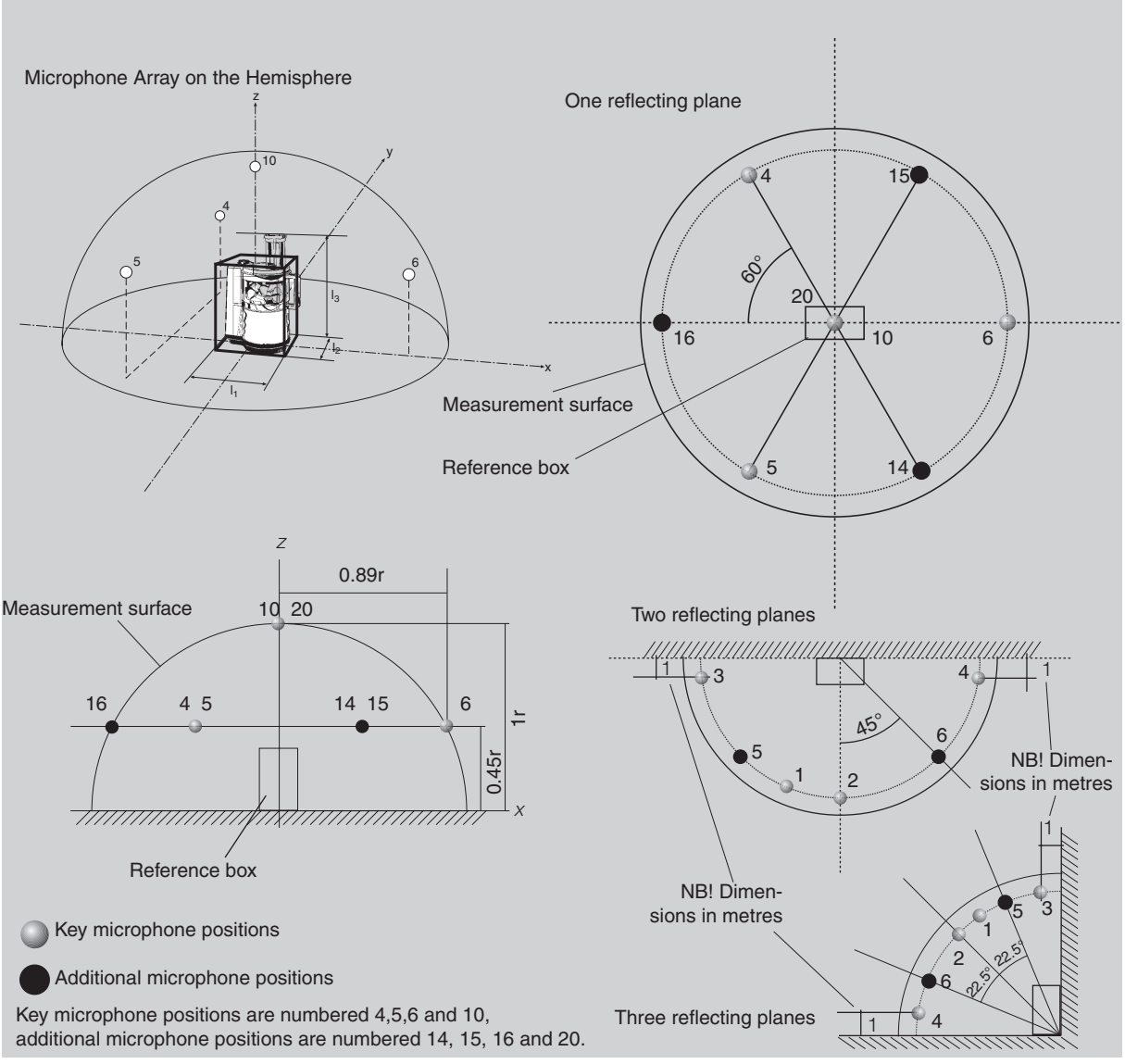
Additional microphone positions

Sound pressure level measurements are required at additional microphone positions on the hemispherical measurement surface if:

- **a** the range of sound pressure level values measured at the key microphone positions (i.e. the difference in decibels between the highest and lowest sound pressure levels) exceeds twice the number of key measurement points, or
- **b** the source radiates noise with a high directivity, or
- **c** the noise from a large source is radiated only from a small portion of the source, e.g. the openings of an otherwise closed machine.

If condition **a** exists, additional microphone positions shall be used. For the microphone array on the hemisphere, an additional 4-point array is defined by rotating the original array through 180° about the z-axis. Note that the top point of the new array is coincident with the top point of the original array. The number of microphone positions is increased from 4 to 7.

Conditions **b** and **c** require more measurements in the region of high radiation.


Microphone Array on the Hemisphere
z
y
x
10
4
5
6
l3
l2
l1
One reflecting plane
4
15
60°
20
16
10
6
5
14
Measurement surface
Reference box
Z
0.89r
Measurement surface
10 20
16
4 5
14 15
6
1r
0.45r
X
Reference box
Two reflecting planes
1
3
4
1
45°
5
6
1
2
NB! Dimen-
sions in metres
NB! Dimen-
sions in metres
1
5
3
1
2
22.5°
22.5°
6
Three reflecting planes
1
4
Key microphone positions
Additional microphone positions
Key microphone positions are numbered 4,5,6 and 10,
additional microphone positions are numbered 14, 15, 16 and 20.

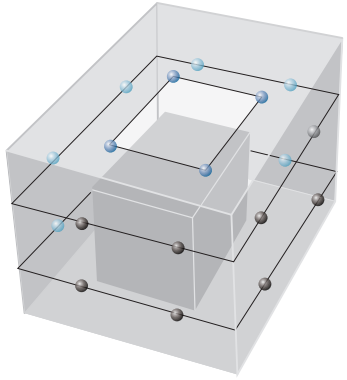
Parallelepiped measurement surface

The measurement distance *d* is the perpendicular distance between the reference box and the measurement surface. The preferred value of *d* is 1 m and should be at least 0.15 m.

The value of *d* should be one of the following values (in metres): 0.15, 0.25, 0.5, 1, 2, 4 or 8. Measurement distances larger than 1 m may be selected for large sources. There are environmental requirements that should be satisfied for the value of *d* selected.

In brief, the environmental requirements state that the reflecting plane must not be of such a material or in such a condition that it radiates any appreciable sound energy due to vibration. If the measurements are made outdoors over grass- or snow-covered ground, the measurement distance shall not exceed 1 metre. The general requirement is that the sound absorption coefficient of the reflecting plane shall be less than 0.1 over the frequency range of interest. Also no reflecting objects that are not part of the source under test shall be located inside the measurement surface.

Microphone array on the parallelepiped – valid for larger machines.



Microphone positions

The microphone positions lie on the measurement surface, a hypothetical surface of area *S* enveloping the source whose sides are parallel to the sides of the reference box and spaced out a distance d (measurement distance) from the box.

The microphone positions on the parallelepiped measurement surface are shown on the following pages. The area *S* of the measurement surface according to the microphone position figures is given by the formula:

$$S = 4(ab + bc + ca)$$

where

$$a = 0.5l_1 + d,\quad b = 0.5l_2 + d \text{ and } c = 0.5l_3 + d$$

and l_1, l_2 and l_3 are the length, width and the height of the reference box.

If a source is installed adjacent to more than one reflecting plane, reference shall be made to the corresponding figures.

Additional microphone positions

Sound pressure level measurements are required at additional microphone positions on the parallelepiped measurement surface if

a the range of sound pressure level values measured at the key microphone positions (i.e. the difference in decibels between the highest and lowest sound pressure levels) exceeds twice the number of key measurement points, or

b the source radiates noise with a high directivity, or

c the noise from a large source is radiated only from a small portion of the source, e.g. the openings of an otherwise closed machine.

If condition **a** exists, additional microphone positions shall be used. For the microphone array on the parallelepiped, the number of microphones are increased as shown on the next page by increasing the number of equally sized rectangular partial areas.

If conditions **b** or **c** exist, additional measurement positions on the measurement surface in the region of high noise radiation shall be used. Details on this are given in the ISO 3746.

Reducing the number of positions

The number of microphones positions can be reduced if preliminary investigations for a particular family of machines show that by using the reduced number of microphone positions, the determined surface sound pressure levels do not deviate more than 1 dB from those determined from measurements over the complete set of microphone positions in accordance with the procedures described above.

An example is when the radiation pattern is shown to be symmetrical.

The overhead position(s) may be omitted for safety reasons, if so stated in the relevant noise test code.

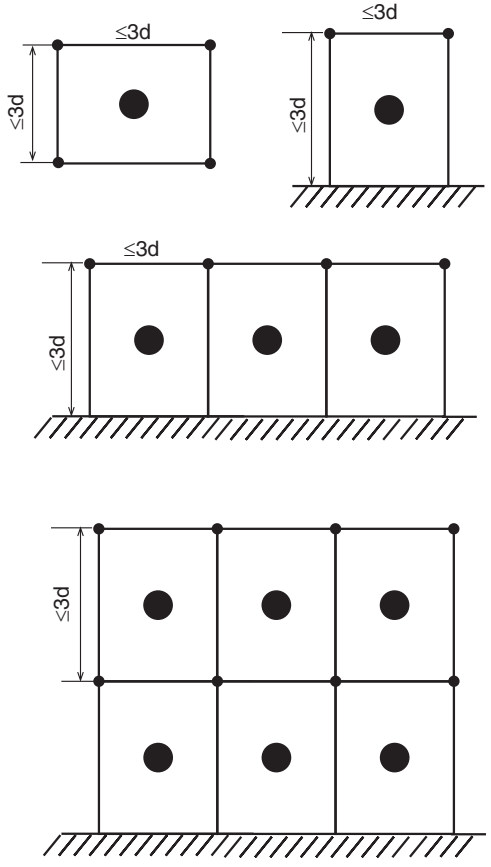
Mic. positions – one reflecting plane

Each plane of the measurement surface shall be considered on its own and so subdivided that the result is the smallest possible number of equal sized rectangular partial areas with a maximum length of side equal to *3d* (see the Fig. to the right). The microphone positions are in the centre of each partial area. In this way the other positions shown overleaf are obtained.

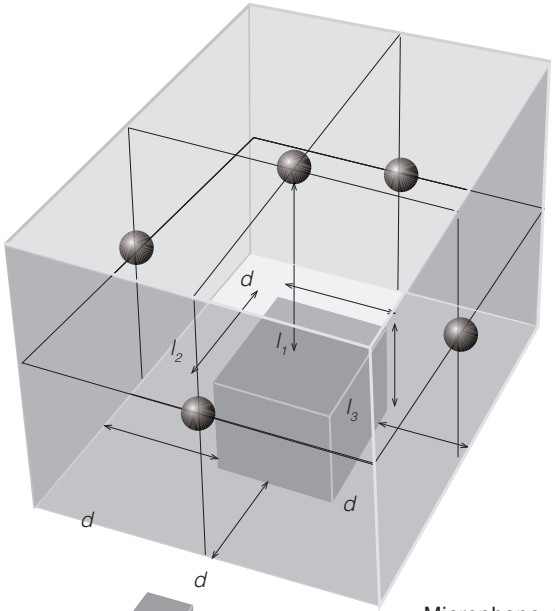
More than one reflecting plane

For a source installed adjacent to more than one reflecting plane, reference shall be made to the figures shown on this page spread for the purpose of defining a suitable measurement surface. Microphone positions are as shown in the Figs).

Procedure for fixing the specified microphone positions where a side of the measurement surface exceeds 3d



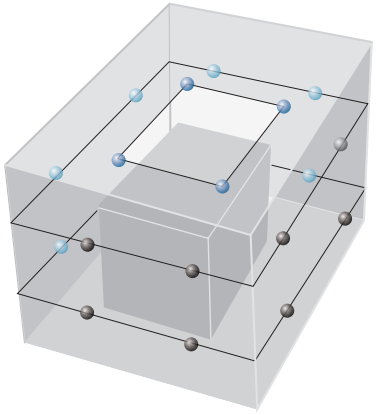
Example of a measurement surface and microphone positions for a small machine…



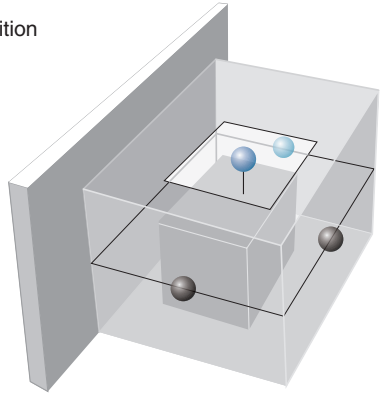
Reference box

Microphone position

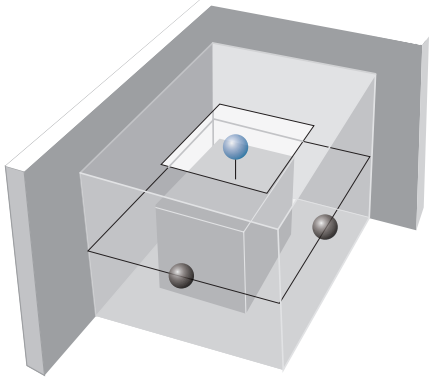
…and an example of microphone placement for a larger machine. Details on the microphone positioning can be found in the ISO 3746.



Microphone placement with four microphones for floor-standing appliances placed against a wall…



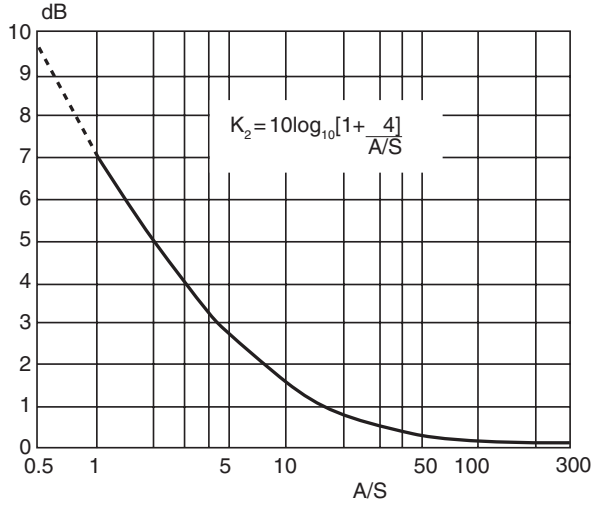
…and three microphones for floor-standing appliances placed in a corner.



Sound power – acoustic environment requirements

A test area outdoors or an ordinary room will provide a suitable environment, if the requirements given in the ANNEX A of the ISO 3746 and briefly outlined here, are satisfied.

When measuring in accordance with the ISO 3746, the environmental correction factor K_2 is obtained from this graph by entering the abscissa with the appropriate value of A/S



Reflecting objects other than reflective plane(s) shall be removed to the extent possible from the vicinity of the machine under test. A test site shall ideally provide a measurement surface which lies

a inside a sound field that is essentially undisturbed by reflections from nearby objects and the room boundaries, and
b outside the near field of the sound source under test.

α	Description of Room
0.05	Nearly empty room, smooth hard walls made concrete, brick, plaster or tile
0.1	Partly empty room, room with smooth walls
0.15	Room with furniture, rectangular machinery or industrial room
0.2	Irregularly shaped room with furniture, irregularly shaped machinery or industrial room
0.25	Room with upholstered furniture, machinery or industrial room with small amount of acoustical material
0.35	Room with acoustical material on both ceilings and walls
0.5	Room with large amounts of acoustical material on ceiling and wall

Calculating the A: The value of the mean acoustic absorption coefficient a is estimated by using the above table. The value of A is then given, in m^2 by $A = a \times S_V$ in which S_V is the total area of the surface of the test room (walls, ceiling and floor) in m^2.

For the purpose of the survey method (the method described here), the measurement surface is considered to lie outside the near field if the measurement distance from the source under test is equal to or greater than 0.15 m.

Specific requirements

Examples of permitted reflecting planes outdoors include compacted earth, artificial surfaces such as concrete or sealed asphalt, while for indoor measurements, the reflecting plane is usually the floor.

Take care to ensure that the reflecting surface does not radiate any appreciable sound energy due to vibration.

The reflecting surface must be larger than the projection of the measurement surface on it.

The sound absorption coefficient (details on this are given in the ISO 354) of the reflecting plane should preferably be less than *0.1* over the frequency range of interest. This requirement is usually fulfilled when outdoor measurements are made over concrete, sealed asphalt or stone surfaces. For reflecting planes with higher sound absorption coefficient, e.g. grass- or snow-covered ground, the measurement distance shall not exceed 1 m. For indoor measurements, wooden and tile floors are also permitted.

No reflecting parts that are not part of the source under test shall be located within the measurement surface.

The K_{2A} factor

The environmental correction factor K_{2A} accounts for the influence of undesired sound reflections from room boundaries and/or reflecting object near the source under test.

The magnitude of this factor depends principally on the ratio of the sound absorption area A of the test room to the area S of the measurement surface. The magnitude does not depend strongly on the location of the source in the test room.

In the ISO 3746, the environmental correction factor K_{2A} is given by

$$K_{2A} = 10\lg[1 + 4(S/A)] \text{ dB}$$

where

A is the equivalent sound absorption area in the room at 1 kHz, in m^2

S is the measurement surface area, in m^2.

Environmental corrections as a function of A/S are illustrated on the previous page.

Approximate method

The mean sound absorption coefficient a of the surface of the room may be estimated using the table shown on the next page. The value A is given, in m^2, by the formula:

$$A = a \cdot S_V$$

in which,

a is the mean sound absorption coefficient, given for A-weighted quantities in the table a few pages ahead.

S_V is the total area of the boundary surfaces of the test room (walls, ceiling and floor), in m^2.

Using reverberation time instead

The classic definition of absorption area is the well-known Sabine's formula:

$$A = 0.163 \frac{V}{T}$$

in which,

V is the volume of the room

T is the reverberation time of the room.

If your Nor118 is equipped with the optional extension 9 REVERBERATION TIME MEASUREMENTS, you may use this to calculate the absorption as follows:

$$K_{2A} = 10\log[1 + 4S/A] \quad [dB]$$

$$K_{2A} = 10\log[1 + 4(S \times T)/(0.163 \times V)] \quad [dB]$$

based on an actual reverberation time measurement.

Test room qualification requirements

For the measurement surface in a test room to be satisfactory for measurements in accordance with the requirements of ISO 3746, the ratio of the sound absorption area *A* to the area *S* of the measurement surface shall be equal to or greater than 1, that is $A/S \geq 1$. The larger the ratio *A/S* is, the better.

If you cannot meet this requirement, a new measurement surface shall be chosen. This surface shall have a smaller total area, but shall still lie outside the near field.

Alternatively you may improve the *A/S* by adding sound-absorbing materials to the test room.

If this does not help, the test room cannot be used for ISO 3746 measurements!

Measuring the sound power

The sound power calculation extension enables you to make a complete sound power measurement, resulting in an L_{WA} value (the A-weighted sound power level) of any test object in accordance with ISO 3746 and related Standards. This means that when equipped with a Nor118 you may test the L_{WA} of new products for the European CE labelling in the production area (*in-situ*), rather than in a laboratory (*in-vitro*).

Making measurements

Before you start to make sound power measurements we recommend that you familiarise yourself with how to make regular sound level measurements.

Then do as follows:

1. Once the test object is properly placed, start the setup procedure by selecting measurement duration as described in *Making simple sound measurements*.

2. Press SETUP followed by 4. The instrument will now enter the measurement control display.

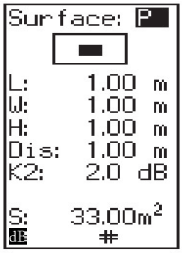
3. The Nor118 allows 1–40 microphone positions to be measured. The initial measurement control display shows 8 positions, but this may be extended to further pages covering the positions 9–40 by pressing the ⇥| key ("next page").

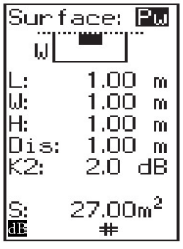
4. At the bottom of the screen, the averaged sound pressure level based on the measured microphone positions, is displayed. Each microphone position is selected by moving the field cursor using the ← or → keys to the selected position, and then pressing the START key. The screen will show the normal measurement display during a measurement, and return to the control screen and display the measured L_{EQA} value for the measured positions at the end of each measurement

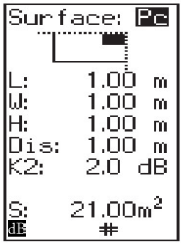
Background noise

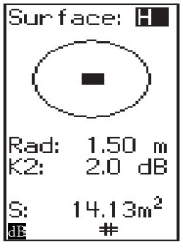
A background noise measurement is required to have the instrument calculate the background noise correction K_1 for you. On pressing the FUNC key, the background noise measurement control display is displayed. This test fol-

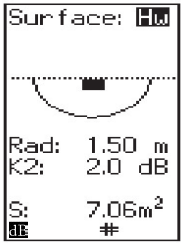
The measurement surface can be either a hemisphere or a parallelepiped. In addition you may choose between different locations of your test object, i.e. on the floor, up against a hard reflecting wall or in a corner…

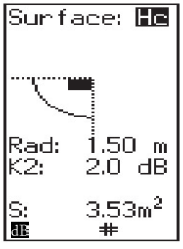






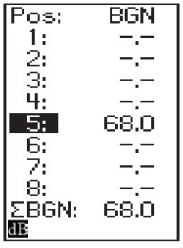






The background noise measurement display…

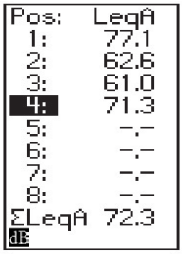
Although the Nor118 lets you measure the background noise level in up to 40 positions, the background noise level will in most situations vary so little from one microphone position to another that it is, for most cases, sufficient to measure the background noise level for one typical microphone position



Use ⇥ (next) and ⇤ (previous) to go between pages

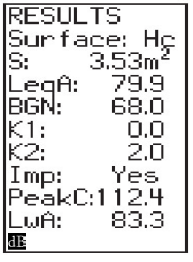
The measurement control display….

Although only 8 microphone positions are shown, there are further "pages" so that a total of 40 microphone positions can be covered. Use the ⇥ key



If you need to know which of the frequency bands that contribute the most to the calculated L_{WA} value, switch to global frequency mode, make a measurement and press the A-PREV key. The spectrum will now appear A-weighted on the screen (purely a display function, the measured data are not affected) and the frequency band(s) contributing the most should now be easy to spot.

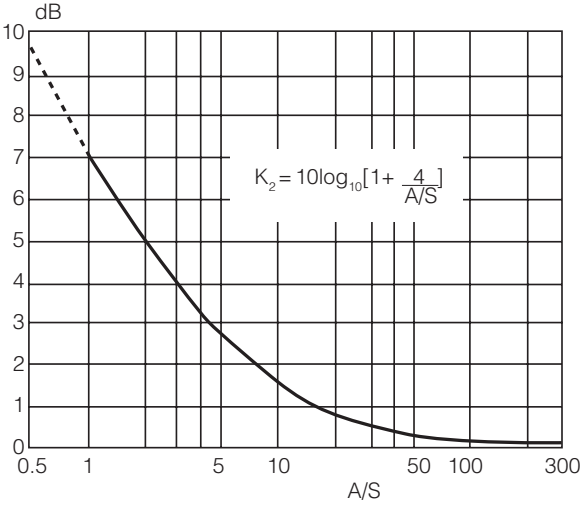
After a successful set of measurements has been made, the results are presented like this upon pressing the TBL key



The results can also be printed out. Turn to *Making hardcopies* for a sample

The environmental correction factor K_2 accounts for the influence of undesired sound reflections from room boundaries and/or reflecting objects near the source under test. The magnitude of this environmental correction factor depends principally on the ratio of the sound absorption area A of the test room to the area S of the measurement surface. The magnitude does not depend strongly on the location of the source in the test room.

When measuring in accordance with the ISO 3746, the environmental correction factor K_2 is obtained from this graph by entering the abscissa with the appropriate value of A/S

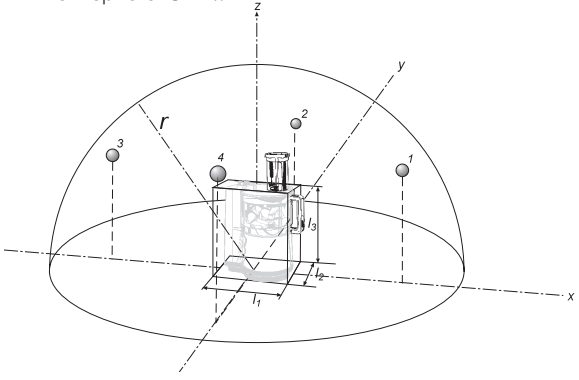


α	Description of Room
0.05	Nearly empty room, smooth hard walls made concrete, brick, plaster or tile
0.1	Partly empty room, room with smooth walls
0.15	Room with furniture, rectangular machinery or industrial room
0.2	Irregularly shaped room with furniture, irregularly shaped machinery or industrial room
0.25	Room with upholstered furniture, machinery or industrial room with small amount of acoustical material
0.35	Room with acoustical material om both ceilings and walls
0.5	Room with large amounts of acoustical material on ceiling and wall

Calculating the A: The value of the mean acoustic absorption coefficient α is estimated by using the above table or by means of reverberation time measurements. The value of A is then given, in m^2 by $A = \alpha \times S_V$ in which S_V is the total area of the surface of the test room (walls, ceiling and floor) in m^2

Calculating the S:

Hemisphere: $S = 2\pi r^2$



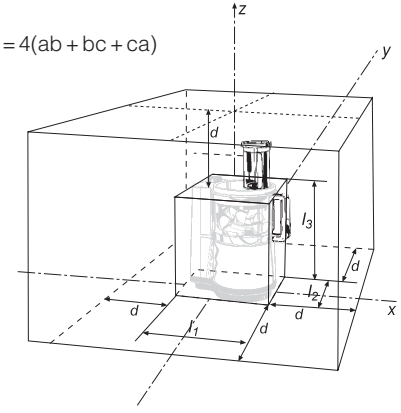
Parallelepiped: $S = 4(ab + bc + ca)$

$a = \frac{l_1}{2} + d$

$b = \frac{l_2}{2} + d$

$c = \frac{l_3}{2} + d$

l_1, l_2, l_3 are the dimensions of the rectangular reference parallelepiped



lows the exactly the same procedures as the sound power measurements.

However, the background noise level will in most situations vary little from one microphone position to another, it will therefore normally be enough to measure the background noise level for one typical microphone position.

To toggle between the measurement control display and the background noise measurement control display:

- Use the FUNC key.

Measurement surface

The sound power calculation requires the operator to select the correct measurement surface.

To select the right measurement surface:

1 Press the SETUP key and choose the corresponding selection in the sound power setup menu. The selected surface is indicated by H for HEMISPHERICAL and P for PARALLELEPIPED with an additional W or C for test objects placed against a WALL or in a CORNER. The selected surface is also indicated by a simple diagram.

2 Depending on the selected surface, the measurement radius or the distance from the reference box (i.e. the minimum box that fits around the test object) must be keyed in. The calculated area *S* of the total measurement surface will then be displayed.

3 Finally, key in the acoustic environment correction K_2.

Sound power results

Based on the averaged sound pressure level of all the microphone positions, the measured background noise level and the selections and corrections made in the sound power setup menu, the Nor118 will display the final L_{WA}.

To see the sound power calculation results:

- Press the TBL key.

- In addition to the overall results, the impulsive noise values, the L_{PEAKC} (or L_{PEAKZ}) level and the noise directivity of the test object for all microphone positions are found by sequential pushes of the TBL key.

The results may also be copied to a printer. The report includes necessary spaces for all the required measurement information to be written directly on the report by the user. On a second page, the individual results for each of the microphone positions are printed. See *Making hardcopies* for more on this.

On the previous pages you will find display examples together with the calculation procedure for the determination of the environmental correction factor K_2, which has been repeated from the previous chapter for your convenience.

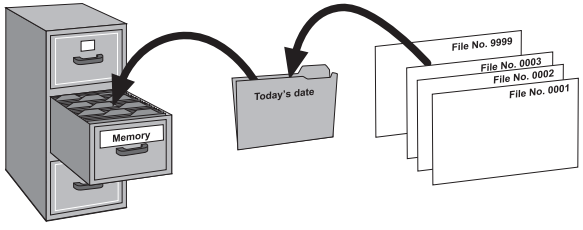
Memory handling

The instrument has a large built-in, non-volatile memory which can hold large amounts of measured data and measurement setups. These data can be printed out and/or transferred to a remote PC for further processing.

Memory structure

The memory structure of the Nor118 is quite similar to that of a PC. They both have folders and files. However, simplicity is a keyword in the Nor118 memory handling, the folder available for storage has the name of today's date and the files are numbered consecutively in ascending order as they are stored, starting at 0001.

A memory structure metaphor



Memory size

The size of the part of the Nor118 internal memory intended for storage of measured data is approximately 5 megabytes. This is a number which says more or less nothing to most people since it reveals nothing of the number of bytes required to store the measured values etc. Let us therefore provide a few examples.

Example 1. The memory can hold more than 10 000 global measurements with all available global functions and distribution when frequency analysis has been deactivated.

Example 2. The memory can hold more than 2 500 global measurements with all available global functions and distribution when frequency analysis has been activated.

Example 3. The memory can hold approximately 2 500 000 samples of L(t) when only one function is logged (requires the enhanced profile extension). This corresponds to more than 60 hours logging with 0.1 s resolution!

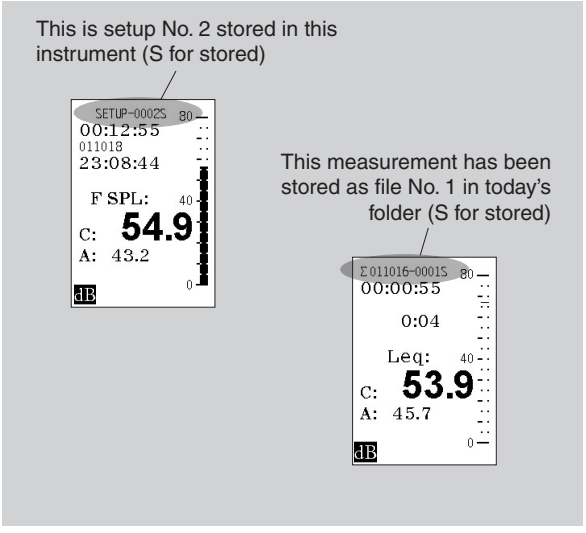
Example 4. The memory can hold more than 90 000 samples of L(t) when all 28 functions are logged in profile (requires enhanced profile and multiple time constants). This corresponds to more than 25 hours with a resolution of 1 s.

Storing a measurement setup

Measurement setups can be stored for future use. This can be handy feature when the instrument is used by several people or for many different tasks.

To store a measurement setup:

- Set up the instrument as required and press STORE *without* making a measurement. Setups are stored in a separate folder called SETUP.



All settings are stored, but upon recall of a setup all settings affecting the hardware is not read back into the instrument. Hardware settings such as baud rate, preamplifer gain and the calibration sensitivity are examples of settings not read back.

However, all settings of functions and parameters used in the measurements are read back.

Storing a measurement

Once a measurement has been made, it can be stored in the non-volatile memory for future use.

To store the data:

- Press the STORE key after a measurement.

The data will now be stored in a folder with the name of today's date. If this folder didn't exist, it will be created by the instrument. The first file gets the number 0001, the next gets the number 0002 etc. If you choose to delete one of the files already stored you will leave a gap in the file list. This gap will not be filled with a file stored later, but be left open. Otherwise, you will easily loose track of which file contains what.

Retrieving stored setups and data

Measurements stored are easily retrieved.

To retrieve a stored setup or stored data:

1 Press the RECALL key.

2 Follow the procedure explained in the side bar.

If you retrieved a stored setup this is now available for use, if you retrieved a stored measurement this is now available for inspection. The fact that you have retrieved something from the memory is reflected in the text line appearing at the top of the display – see Fig.

Clearing files and folders in the memory

To delete files and folders in the directory:

- Press the CLEAR key. The display will now produce the CLEAR menu.

In order to successfully locate the files and folders you want to delete, you must apply the procedures discussed in *Retrieving stored setups and data* (including the side bar on this page).

Clearing a single file

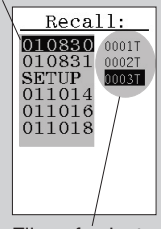
To clear a single file:

1 Make sure that the file to be cleared is selected, i.e. highlit (shown as white text on a black background). Press the ENTER key. You will now be prompted to confirm your action. However, as default the cursor is positioned on the CANCEL field to avoid erasing the wrong file.

2 Use the CURSOR keys to move the cursor to CUR.FILE and press ENTER again. The file is now deleted.

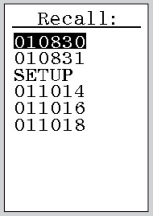
Retrieving stored setups and data

Folders

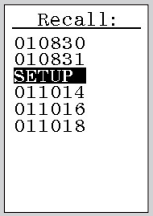


Files of selected folder

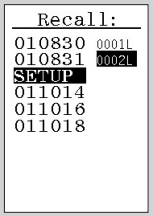
Once you've pressed the RECALL key, the display wil show a list of folders and the contents of one of them(here this is the folder 010830). Use the VERTICAL CURSOR keys to move up and down in the file list of this folder.



To be able to scroll in the folder list, press the ⇐ key once and then use the VERTICAL CURSOR keys to move to the required folder



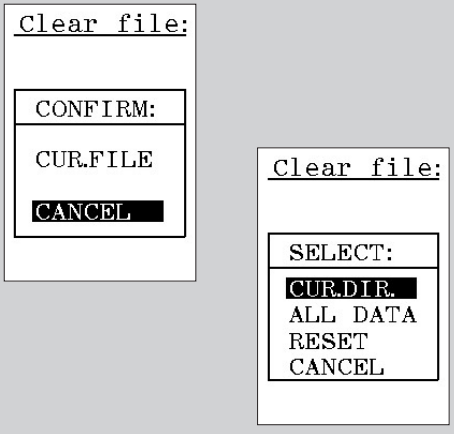
For example the folder containing all the setups…



To display the files contained in the selected folder, press the ⇒ key and locate the file in question by means of the VERTICAL CURSOR keys.

Press ENTER to recall the located file/setup and EXIT to leave the menu without recalling any file/setup

The menus for clearing files, folders and the entire memory



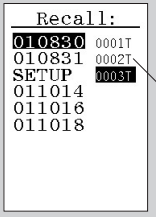
Clearing folders or the entire memory

To clear a folder:

- Select it using the cursor keys and press enter. You will now be prompted to select between clearing the CUR.DIR. (i.e. the current folder or directory, ALL DATA in the entire memory or to RESET the entire memory. The option CANCEL is also included to avoid unintended erasures. If so, use EXIT to leave the menu.

You cannot delete the file that you are displaying. Therefore, in order to clear this file press EXIT before you enter the CLEAR menu.

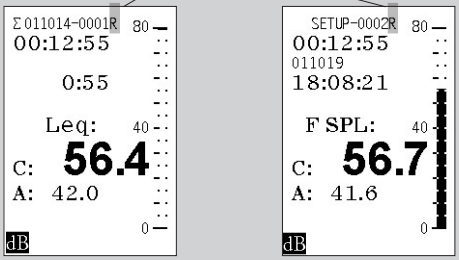
Keeping track of the measurement mode the file was stored in. The different modes are indicated in the file list as follows:



All file names (i.e. file numbers) have a letter as suffix. This letter indicates the measurement mode:

F means frequency analysis, but no profile
L means that the file contains a simple global measurement, but no frequency analysis and no profile.
M means a multispectrum measurement
P means a measurement made in sound power mode.
R means a reverberation time measurement
T means a profile measurement with or without a frequency analysis

The uppermost text line in the display which file has been retrieved. The little R denotes Recalled, just like S denotes Stored



Making hardcopies

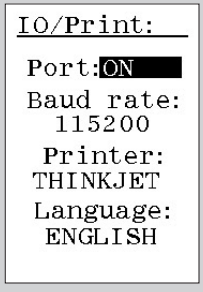
Measured data can be output to a printer for documentation. The instrument's print drivers support the following printer types:

- HP THINKJET class of printers
- HP DESKJET class of printers
- DICONIX range of printers
- Most numerical printers

The range of printers commercially available is an ever changing issue. Therefore what was true by the time of design of the printer drivers used in Nor118 may not be true the day you read this. Output from the Nor118 is purely numerical, hence almost any numerical printer should be able to produce the output text on the paper. The difference between the printers lies mostly in such things as character size and width, which determines the number of characters that fit on a page.

Therefore we recommend that you make a few experiments with the setup and your printer to find the driver that produces the best-looking printouts.

Press SETUP>1>2 to produce this menu



Setting up for printouts

The setup for printouts is made in the IO/Print menu.

To set up for printing:

1 Press SETUP > 1 (Instr) > 2 (IO/Print).

2 Set the SERIAL INTERFACE PORT to ON (set it to OFF when not used to save batteries); set a baud rate your printer can handle – be sure to use the same setting in the printer; experiment with the printer type (see above) and unless you're in need of printouts with German text, set language setting to ENGLISH.

Printing out measured data

To print out measured data, be sure to visit the Prnt par menu first. This menu lets you decide which of the measured functions should be printed out. The menu comes in two flavours, depending on whether your instrument is equipped with multiple time constants or not.

To set which functions to print out:

1 Press SETUP >1 >8.

2 Use the CURSOR keys to navigate and the INC and DEC keys to set the functions to be printed. A **1** means that the function will appear in the printout.

3 Units equipped with the enhanced profile extension allows you to select which functions to log as level vs. time. Once you've set up this table and pressed ENTER to put changes into effect, the instrument will prompt you to decide whether this setup shall be copied to the Prnt par. menu as well, for convenience. Note that this applies to profile printouts only.

To start a printout:

1 Set up everything as required.

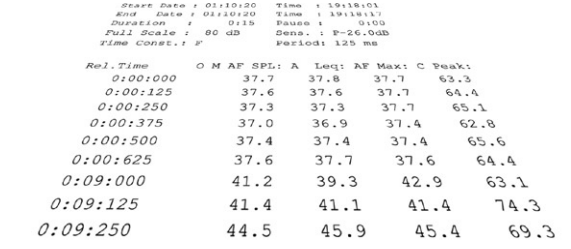
2 Press the PRINT key.

For level and frequency analysis measurements the entire data set will be printed out. For profile measurements the printout will contain the periods from the present cursor position till the end of the time record.

How to print the level, the profile and the frequency spectrum:

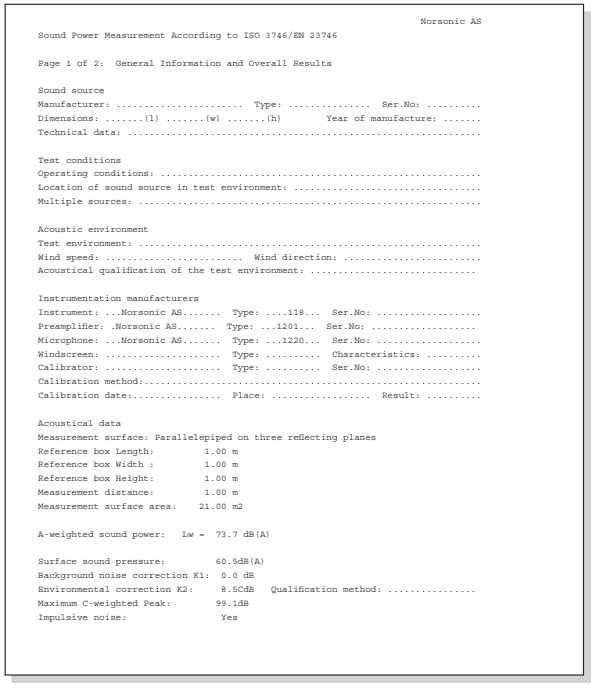
- You decide what to print by what you display by the time you press the PRINT key. This means that to print the spectrum, you must display the spectrum on the screen, to print the profile you must display the profile and so on.

Two printout examples, a profile and a sound power measurement output



```
Start Date : 01:10:20   Time  : 19:18:01
End   Date : 01:10:20   Time  : 19:18:17
Duration   :    0:15    Pause :    9:00
Full Scale :  90 dB     Sens. : P-26.0dB
Time Const.: F          Period: 125 ms

Rel.Time      O M AF SPL: A  Leq: AF Max: C Peak:
  0:00:000        37.7    37.8    37.7    63.3
  0:00:125        37.6    37.6    37.7    64.4
  0:00:250        37.3    37.3    37.7    65.1
  0:00:375        37.0    36.9    37.4    62.8
  0:00:500        37.4    37.4    37.4    65.6
  0:00:625        37.6    37.7    37.6    64.4
  0:09:000        41.2    39.3    42.9    63.1
  0:09:125        41.4    41.1    41.4    74.3
  0:09:250        44.5    45.9    45.4    69.3
```



```
                                                                Norsonic AS
Sound Power Measurement According to ISO 3746/EN 23746

Page 1 of 2:  General Information and Overall Results

Sound source
Manufacturer: ........................ Type: ..............  Ser.No: ..........
Dimensions: .......(l) .......(w) .......(h)        Year of manufacture: .......
Technical data: ..................................................................

Test conditions
Operating conditions: ............................................................
Location of sound source in test environment: ....................................
Multiple sources: ................................................................

Acoustic environment
Test environment: ...............................................................
Wind speed: ..........................  Wind direction: ..........................
Acoustical qualification of the test environment: ..............................

Instrumentation manufacturers
Instrument: ...Norsonic AS.......  Type: ....118...  Ser.No: ....................
Preamplifier: .Norsonic AS.......  Type: ...1201...  Ser.No: ....................
Microphone: ...Norsonic AS.......  Type: ...1220...  Ser.No: ....................
Windscreen: ......................  Type: ..........  Characteristics: ..........
Calibrator: ......................  Type: ..........  Ser.No: ....................
Calibration method:..............................................................
Calibration date:..................  Place: ....................  Result: ..........

Acoustical data
Measurement surface: Parallelepiped on three reflecting planes
Reference box Length:          1.00 m
Reference box Width :          1.00 m
Reference box Height:          1.00 m
Measurement distance:          1.00 m
Measurement surface area:     21.00 m2

A-weighted sound power:   Lw =  73.7 dB(A)

Surface sound pressure:          60.5dB(A)
Background noise correction K1:  0.0 dB
Environmental correction K2:      8.5CdB   Qualification method: ................
Maximum C-weighted Peak:         99.1dB
Impulsive noise:                  Yes
```

Noise monitoring

Due to its large memory and the high dynamic range, the Nor118 is well-suited for noise monitoring applications. Some installations, semi-permanent or permanent, are based on tight computer control, while others leave more of the job to the measuring instrument itself.

The Nor118 can be used with success in both types of systems.

The Norsonic environmental solutions contain a complete range of equipment and accessories for environmental noise measurements and monitoring, all the way from outdoor microphone units, via enclosures and transmission cables to controlling and post-processing software. A detailed presentation is available on www.norsonic.com.

Automated storage of measured data

The Nor118 can be set up to measure for a predefined period in time and then store the measured data. Once the data have been stored, the instrument will start to measure for another period of the same duration and then store the acquired data, start again and so on.

The snag, however, is that a little time will always be spent on storing the acquired data. This means that if you, for example, set up the instrument to measure in periods of an hour and start the measurement exactly on the hour, the measurement period start time will exhibit a lag after some hours of measuring – typically 3–4 seconds per individual measurement.

If this lag is unacceptable for you, we recommend that you use the *synchro* feature. When activated, the synchro will stop the measurement slightly earlier (4 seconds to be exact!) to give room for data storage and housekeeping so that the measurement will start exactly on the hour.

Available storage modes

The Nor118 will always operate in one of four available storage modes. These are:

- Manual, which requires that acquired data are stored manually by the operator before the next measurement is made

- Automatic, which causes the acquired data to be stored automatically upon measurement termination, regardless of the reason for termination – irrespective

of whether termination took place because the duration expired or because you pressed STOP.

- REPEAT, which causes the instrument to store the acquired data and then restart immediately and make another measurement using the same measurement setup and duration. Repeat applies to measurements terminated by themselves only. If you terminate a measurement by pressing STOP, the instrument will not restart. Note that some time will be spent on storing the acquired data, Therefore a slight delay (typically 3–4 seconds) in the restart moment will be observed.

- SYNCHRO, which compensates for the time spent on housekeeping (i.e. storage of data etc.) to maintain synchronisation with the time of day. This works in the way that the instrument synchronises itself with the full hour of the time of day. To be active, SYNCHRO requires a minimum measurement time (duration) of 30 seconds per individual measurement.

Synchro – an example

Assume that you set up the instrument to measure in periods of one hour and that you start the measurement at 08:52:40. The first period will be truncated and last a little less than 7 minutes and 20 seconds (it will last for 7 minutes and 16 seconds to be exact) to give room for storage before 09:00:00. The succeeding period will then each be very close to an hour long to enable restart again at 10:00:00, 11:00:00 etc.

Now, what happens if you select a period duration whose multiples fail to match one hour? If you set up the period duration to, say 7 minutes, and start the measurement, the instrument will measure in periods of 6 minutes and 54 seconds to enable a restart exactly 7 minutes after the previous period started.

However, the first time the full hour is reached, one period will be truncated (if needed) to lock the measurement onto the full hour at least once. The odd choice of period length will, however, fail to make the full hour synchronisation work in a sensible way. The principle has been designed with period lengths of an hour, half an hour, 15 minutes etc. in mind.

Going to measure very high levels? As an optional extension the Nor118 is able to measure very high sound pressure levels without changing the microphone cartridge – see *High levels* in the *Technical specifications* for details.

Keyboard lockout – locking the keyboard to prevent unauthorized operation. You may lock the keyboard to prevent the instrument from being tampered with while it is left on its own.

To lock the keyboard:

Press |←, →, →|, ← to lock the keyboard

To unlock a locked keyboard:

Press ←, →|, →, |← to unlock the keyboard

Note that the instrument must show the sound level meter display for this to work (in this display the CURSOR keys are not used).

Setting the storage mode

To set the storage mode:

- Press SETUP > 1 (Instr.) > 1 (Storing). Use the cursor keys (located below the display) to navigate in the menu as usual and set the storage mode as required.

Other setup aspects

The setup for a monitoring job will depend on the task, so no absolutes can be given here. However, you should consider such things as

- What information will you need, and how detailed should it be?

Using windscreen? The effect of using a windshield is discussed in *Windscreen* in the chapter *Technical specifications*.

- Measurement period length
- Profile resolution required (if applicable)
- The need for frequency analysis and bandwidth (if applicable)
- The functions to be measured (requires extension 5 and/or 7)
- The need for statistics (if applicable)
- The type of outdoor microphone unit (for semi-permanent or permanent installations)
- Adaptors needed (if applicable)
- Cabinet or casing required for the sound level meter
- Cables and cable-lengths
- External power to the instrument (batteries or mains connection)
- Type of connection to remote PC (modem, GSM modem, directly wired to the PC or maybe you will come by at regular intervals with your PC to download acquired data)

The setup of Nor118 will be found in this manual, while all the accessories can be found in a separate leaflet or on www.norsonic.com.

Transfer of data to a PC

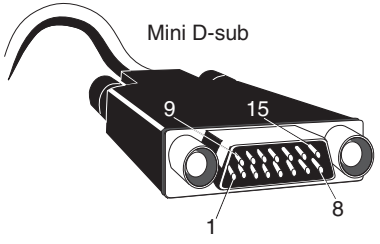
To transfer measured data from the Nor118 to a PC you will need a Nor1441 cable (available separately, contact your local representative or the factory).

To transfer measured data via a modem, you will need a Nor1489 cable for GSM modems and Nor1490 for conventional modems. Both cables are available separately..

An easy way to transfer data to a PC is by means of the software program NorXfer, (available separately).

The instrument can also be controlled from remote. For a complete list of remote control commands contact your local representative or the factory.

Pin-out of the cable Nor1441, the other end is standard RS232 fitting directly into your PC.



Pin	Signal	Dir.	Remarks
1	DO-1	Out	Digital output
2	DO-2	Out	Digital output
3	DO-3	Out	Digital output for calibration only (high = calibration ON)
4	DTR	Out	RS232
5	TD	Out	RS232
6	PWR	Out	3.3V, max 10 mA
7	GND		ref. digital lines
8	DI-1	In	Digital input
9	DI-2	In	Digital input
10	HEAT1	In	Power, mic. heating
11	HEAT0	In	Ref. for HEAT1
12	DSR	In	RS232
13	RD	In	RS232
14	GND		ref. analogue signal
15	AC-out	Out	Analogue output
Housing	GND		Instrument casing

Technical specifications

Unless stated otherwise, the specifications are for the complete sound level meter Nor118 equipped with microphone type Nor1225 and microphone preamplifier type Nor1206. Values are based on the sensitivity set to the nominal value for the microphone: –26.0 dB corresponding to 50 mV/Pa.

A microphone cable Nor1408 of length up to 20 m may be used between the microphone preamplifier and the instrument body without loss of performance. Longer cables may be used if maximum sound pressure level or frequency is reduced.

The definition of terms is based on IEC 61672-1 (In draft form at the time of printing).

The options included in the basic instrument may vary. Please check with your local supplier for the latest information.

Type of instrument

Sound level meter IEC 61672-1, CLASS 1, GROUP X measuring exponential time-weighted levels, integrating-averaging levels and sound exposure levels. If 1/1 octave-band or 1/3 octave-band filters are installed, the instrument complies with IEC 61260, CLASS 1; IEC 60 651 TYPE 1 and IEC 60804 TYPE 1.

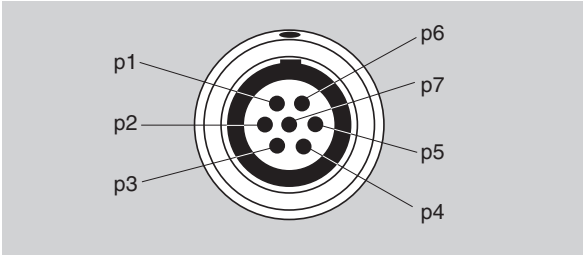
Analogue inputs

Number of channels: 1
Input connector: 7 pin LEMO connector for Norsonic microphone systems. (LEMO ECG.1B.307.CLL)
Preamplifier supply voltage: ± 15 volt, max 3 mA
Polarisation voltage: 0 V and 200 V, selectable.
Maximum input signal: ± 11 V peak
Input impedance: More than 100 kohm, less than 650 pF

Measurement range: 0.3 mV to 7 V (RMS) in one range corresponding to –10 dB to 137 dB with a microphone sensitivity of 50 mV/Pa. The maximum peak value ±10 V corresponds to 140 dB.

With the optional extension permitting extended measurement range, peak values up to 150 dB may be measured.

Microphone input socket



Pin	Function
1	Heater supply (Ref pin no 7)
2	GND – signal reference
3	Polarisation voltage – selectable: 0±1 V, 200±2 V short-circuit current <1mA, impedance: 2 MΩ
4	Signal input
5	+15±0.5 V preamplifier supply voltage, max 3 mA (Connected to pin 6)
6	+15 V, (Connected to pin 5)
7	-15±0.5 volt, preamp. supply voltage, max 3 mA Housing is GND instrument casing.

Highpass filter

The input section is equipped with a highpass filter to reduce noise from wind or other sources with frequencies below the frequency range for measurements.

Filter type: 3rd order HP filter (-3 dB at 4 Hz, Butterworth response)

Analogue to digital conversion

The analogue input signal is converted to a digital signal by a multirange sigma-delta converter with an effective sampling frequency of 48 kHz. The anti-aliasing filter is a combination of an analogue and a digital filter.

Frequency weightings

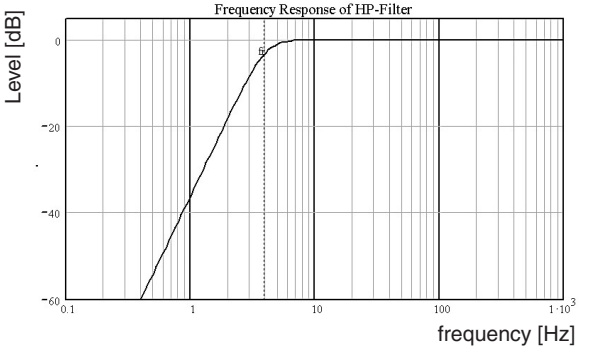
Simultaneous measurement of A- and C-weighting or A- and Z-weighting. ¹⁄₁ octave band or ⅓ octave band levels may be measured simultaneously if options providing these weightings are installed.

Filters: ¹⁄₁ octave filters: 8, 16, ...16000 Hz, class 1, digital IIR filters, base 10 system. (IEC 61260). **⅓ octave filters:** 6.3, 8, 10, ... 20000 Hz, class 1, digital IIR filters, base 10 system (IEC 61260).

Level detector

Detector type: Digital true root-mean-square (RMS) detection and peak detection, resolution 0.1 dB which may optionally be increased to 0.01 dB for indicated levels in the range –9.99 to 99.99 dB.

Highpass filter frequency response



Crest factor capability: The crest factor is only limited by the peak-value of the signal.

Time weightings and measured functions

Simultaneous measurement of the following functions:

- F–time-weighted sound pressure level, instantaneous
- Maximum F–time-weighted sound pressure level
- Minimum F–time-weighted sound pressure level
- S–time-weighted sound pressure level, instantaneous
- Maximum S–time-weighted sound pressure level
- Minimum S–time-weighted sound pressure level
- I–time-weighted sound pressure level, instantaneous
- Maximum I–time-weighted sound pressure level
- Minimum I–time-weighted sound pressure level
- Integrated-averaged sound pressure level
- Sound exposure level
- Peak sound level
- Exceeding level for F–time-weighted sound pressure level (cumulative distribution)

As an option, the sound level meter may also simultaneously measure:

- Integrated-averaged I–time-weighted sound pressure level
- I–time-weighted sound exposure level
- Taktmaximalpegel – DIN 45657, F time response, 5 seconds TAKT.

Level distribution

As an optional extension, the instrument may be fitted to calculate the exceeding level (cumulative level distribution) for the F time weighted level. The calculation is done for frequency weightings A and C or Z and for 1/1 octave or 1/3 octave filters (if present and used in a measurement)

Class width: 0.2 dB
Number of classes: 652 for levels between 10 dB above full scale (140 dB) and 120 dB below full scale (10 dB). The classes for the highest and lowest levels are extended to also include levels above and below, respectively.
Sampling frequency for level: 10 samples per second
Display resolution: 0.1 dB based on interpolation

Indication range

The calibration of the instrument allows microphones with sensitivity in the range –84 dB to +15.9 dB relative to 1 volt/pascal to be applied. The corresponding display range for the indicated sound level is –50 dB to +180 dB.

Self-noise levels

The self-noise is measured with the calibration set to –26.0 dB corresponding to a microphone sensitivity of 50 mV/Pa. For voltage input, the level 0 dB then corresponds to 1mV. Typical values for the self-noise are 5 dB lower than the values stated. The noise levels are measured without light in the display.

Noise measured with 18 pF microphone dummy and microphone preamplifier Nor1206, averaged over 30 s of measurement time:
Spectral weighting functions: A-weighted: 13 dB, C-weighted: 15 dB, Z-weighted: 25 dB
Filter bands: 1/3 oct: 6.3 Hz to 250 Hz: 10 dB (option)
1/3 oct: 315 Hz to 20 kHz: 5 dB (option)

Noise measured with Nor1225 microphone and preamplifier Nor1206, averaged over 30 s of measurement time:
Spectral weighting functions: A-weighted: 18 dB, C-weighted: 22 dB, Z-weighted: 30 dB

Filter bands: ⅓ oct: 6.3 Hz to 250 Hz: 15 dB (option), **⅓ oct: 315 Hz to 20 kHz:** 10 dB (option)

Noise measured with the input terminal on the sound level meter short-circuited to ground, averaged over 30 s of measurement time:
Spectral weighting functions: A-weighted: 10 dB, C-weighted: 10 dB, Z-weighted: 15 dB
Filter bands: ⅓ oct: 6.3 Hz to 250 Hz: 0 dB (option)
⅓ oct: 315 Hz to 20 kHz: 7 dB (option)

Field calibration

The recommended sound calibrator for verification of the sensitivity of the sound level meter is Norsonic Nor1251 with a nominal sound pressure 114.0 dB at 1 kHz. In order to compensate for effects due to diffraction around the microphone, we recommend adjusting the sound level meter to indicate 113.8 dB (diffuse correction off).

If other types of calibrators or electrostatic actuators are used for the calibration, we recommend adjusting the sound level meter to indicate the following levels referred to the sound pressure acting on the diaphragm of the microphone (diffuse correction off):

Freq	125 Hz	250 Hz	1 kHz	4 kHz	8 kHz
Level	0.0 dB	0.0 dB	–0.2 dB	–0.8 dB	–2.8 dB

Measurement duration and resolution

The total time period for a measurement (global period, designated Σ) may be set from 1 second up to 100 hours less 1 second with 1 second resolution. The global period may be subdivided in shorter periods, designated time resolution (Δ) from 1 second up to the global period. As an option the time resolution may be set in an additional range: from 100 millisecond and upwards to 1 second in steps of 25 millisecond.

Total range for measurement of A-weighted levels

The linear operating range is identical to the total range.

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	98 dB	137 dB	138 dB	136 dB	133 dB
Lower level	24 dB	24 dB	24 dB	24 dB	24 dB
Ref level test	94 dB	114 dB	114 dB	114 dB	114 dB

The primary indicator range for compliance with IEC 60651 type 1 is 24 dB to 117 dB. For compliance with IEC 60804 type 1, the linearity range is 24 to 137 dB, and the pulse range 24 dB to 140 dB, respectively.

Total range for measurement of C-weighted levels

The linear operating range is identical to the total range.

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	134 dB	137 dB	136 dB	134 dB	131 dB
Lower level	30 dB	30 dB	30 dB	30 dB	30 dB
Ref level test	114 dB	114 dB	114 dB	114 dB	114 dB

Total range for measurement of Z-weighted levels

The linear operating range is identical to the total range.

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	137 dB	137 dB	137 dB	137 dB	137 dB
Lower level	40 dB	40 dB	40 dB	40 dB	40 dB
Ref level test	114 dB	114 dB	114 dB	114 dB	114 dB

Measurement range for C-weighted peak levels

Frequency	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper level	137 dB	140 dB	139 dB	137 dB	134 dB
Lower level	45 dB	45 dB	45 dB	45 dB	45 dB
Ref level test	114 dB	114 dB	114 dB	114 dB	114 dB

Power supply

Battery: 4 cells, IEC LR6, AA-sized, ALKALINE batteries are recommended (e.g. DURACELL ULTRA M3). AA-sized NiCd or NiMH rechargeable batteries may be used, but must be charged outside the instrument. Battery voltage and time on battery since last change of batteries are indicated.

Typical battery life time (DURACELL ULTRA M3)**:** 8 hours.

External DC: 11 – 15 volt. Power consumption approximately 1.4 watt dependent on selected modes of operation. External DC source should have source-impedance less than 1 ohm and be able to supply at least 300 mA. The mains adaptor Nor340 is recommended for use with the instrument.

If the external supply falls below 9 V, the instrument will use the internal batteries if available. If the instrument has switched off due to loss of power or insufficient supply voltage, the instrument will automatically switch on and resume normal operation after reapplying the external DC supply.

Socket for external DC: 1.3 mm plug, negative voltage on centre-terminal.

The instrument will automatically switch off if the battery or external voltage is too low for operation within the stated specifications. The maximum battery voltage for conformance testing is 4 × 1.6 V = 6.4 V.

The instrument has a calendar clock with a typical lifetime of more than 10 years. Contact your Norsonic service department for change of this component. After replacement the instrument need factory calibration and to re-install the options.

Display

The display is a monochrome, transreflective LCD graphical display with 160×240 pixels (W×H) with automatic temperature compensation for contrast and viewing angle. Pressing the LIGHT key illuminates the display. The light switches off automatically 2 minutes after the last operation of any key.

The bar graph display covers 80 dB, which may be scrolled in 10 dB steps to cover the total range.

Keyboard

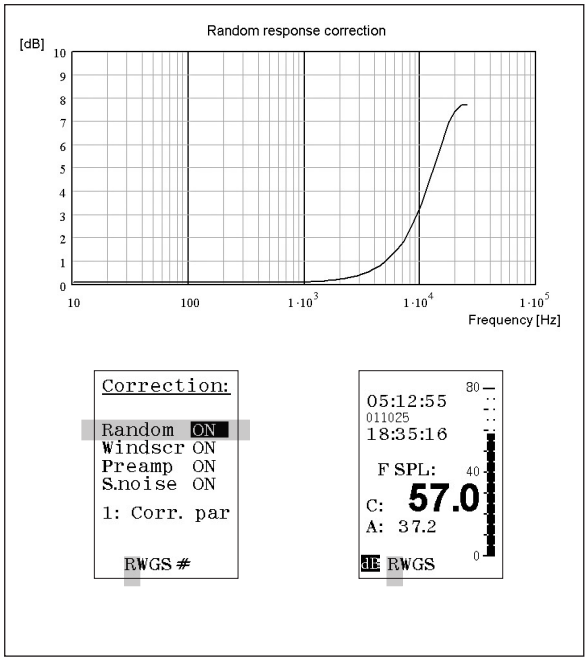
The keyboard is of foil type with acoustic feedback when the keys are depressed. Keys used during a measurement or for initiating a measurement remain silent.

Adjustment of indicated levels

Random response. The instrument is equipped with a microphone with flat free-field response and satisfies the class 1 requirements in IEC 61672-1 to free-field response. By selecting the random response correction network included, the instrument will satisfy the class 1 requirements in IEC 61672-1 to random response as well as ANSI S1.4-1997 TYPE 1. The nominal correction to obtain flat random response is shown in the figure below.

Activating random response correction:

- Press SETUP > 1 (Instr.) > 6 (Correct.) to gain access to the Corrections menu. Navigate in the menu as usual and activate the correction parameter Random



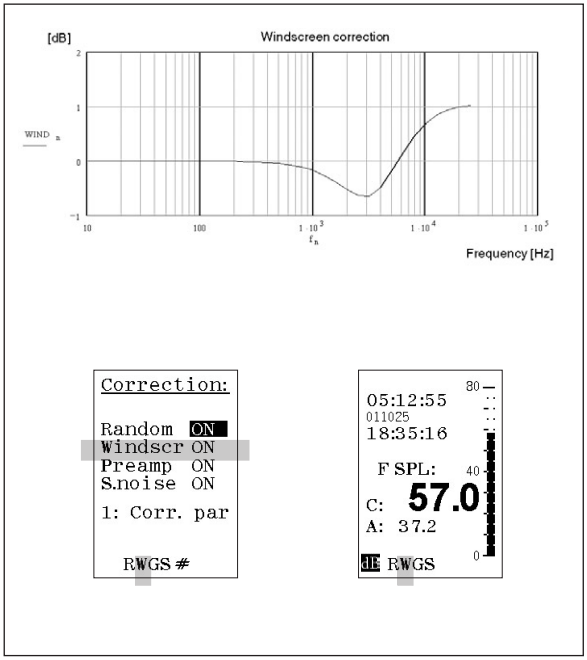
by means of the INC and DEC keys. Do the same to deactivate. Random response correction activated is indicated by an **R** in the lower line of the display.

Windscreen

The instrument may be used with windscreen Nor1451. The windscreen correction has to be switched on to obtain the stated specifications. The nominal correction for the windscreen correction network is shown in the figure below.

Activating windscreen correction

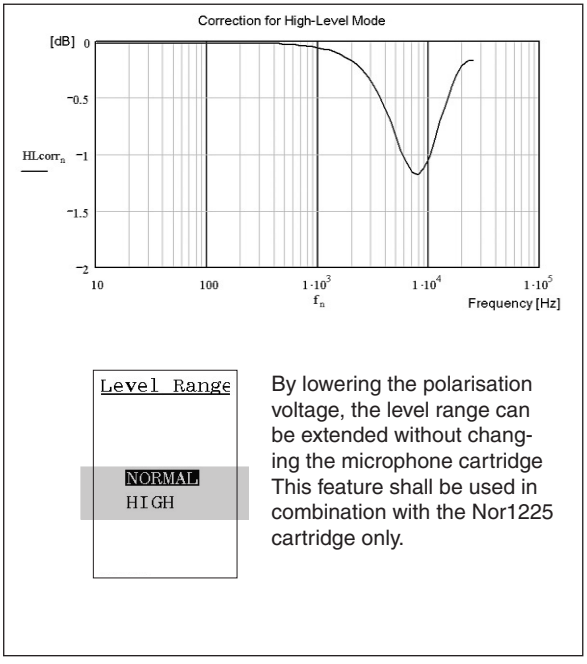
- Press SETUP > 1 (Instr.) > 6 (Correct.) to gain access to the Corrections menu. Navigate in the menu as usual and activate the correction parameter Windscr by means of the INC and DEC keys. Do the same to deactivate. Windscreen correction activated is indicated by a **W** in the lower line of the display.



High levels

As an option, the instrument may measure levels 10 dB higher than stated as the standard range. The extended measurement range is obtained by reducing the sensitivity of the microphone through the application of a lower polarisation voltage. When this option is selected, the

polarisation voltage is lowered from 200 V to about 70 V. A correction network is applied automatically to compensate for the change in frequency response of the microphone due to the lower polarisation voltage. The nominal response for the "high level correction network" is shown in the figure below.



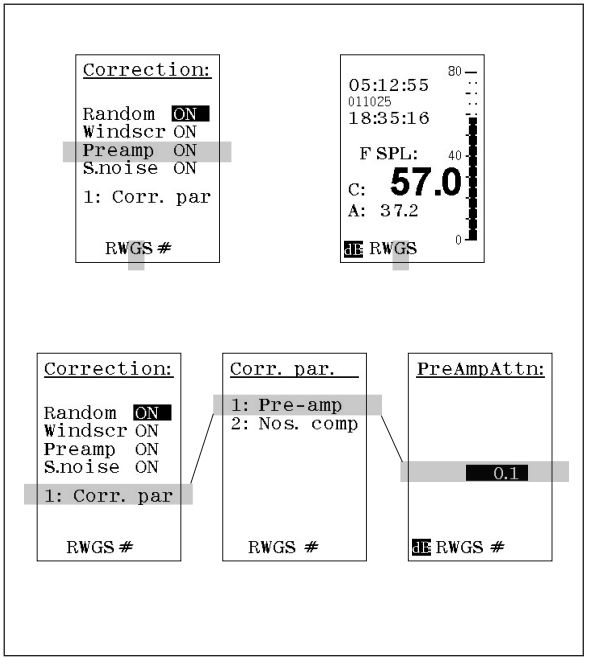
Note that the needed correction will depend on the type of microphone, and shall only be applied when using microphone cartridge type Nor1225.

Activating the high level range:

- Press SETUP > 5 (Lvl.range) to gain access to the level range setting menu. Navigate in the menu as usual.

Preamplifier attenuation

The instrument has the ability to correct for the attenuation in the preamplifier. Typical values of the attenuation is 0.2 dB. The correction can be set in the range 0.0 to 9.9 dB. The correction can be switched ON/OFF to facilitate applications of other transducers without preamplifier.



Activating the preamplifer attenuation:

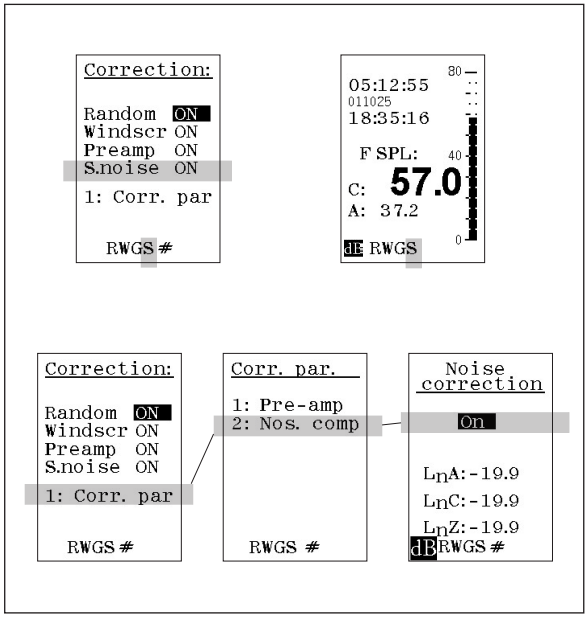
- To activate the preamplifier attenuation press SETUP > 1 (Instr.) > 6 (Correct.) to gain access to the Corrections menu. Navigate in the menu as usual and activate the correction parameter Preamp by means of the INC and DEC keys. Do the same to deactivate. Preamplifier attenuation activated is indicated by a **G** (for Gain) in the lower line of the display

Setting the amount of attenuation:

- In the Correction menu, press 1 (Corr.par) to gain access to the correction parameter setup menu. Press 2 to gain access to the attenuation setting itself. Never change this setting unless you know what you're doing! Use the NUMERICAL KEYPAD to set the attenuation value. Press ENTER twice to leave the menu. See Fig. on the previous page for menu details

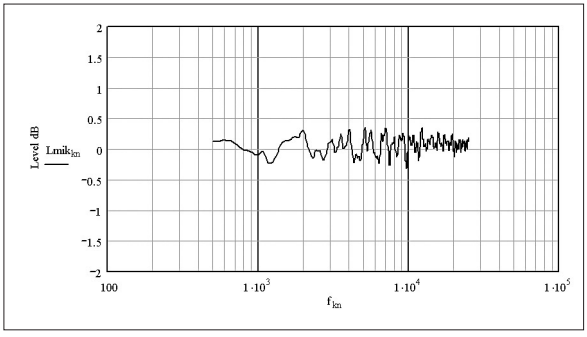
Self-noise compensation

The displayed values for A-, C- and Z-weighted levels may, as an option (extension 20), be corrected automatically for the self-noise of the microphone. The noise levels for each of the spectral weightings must be specified. The correction is applied by unlinear level subtraction. The option allows levels close to the self-noise to be displayed with reduced level linearity error. When the level is equal to the self-noise level, the correction is –3 dB.



Diffraction around the instrument casing

The instrument casing is designed to have low effects on the sound measured at the microphone. The figure below shows the measured effect of the instrument casing at reference environmental conditions.



General I/O socket

A 15 pin socket for general I/O is placed on the right-hand side of the instrument. Socket type:ITT CANNON MDSM-15PE 250-8550-021.

The general I/O socket

Pin	Signal	Dir.	Remarks
1	DO-1	Out	Digital output
2	DO-2	Out	Digital output
3	DO-3	Out	Digital output for calibration only (high = calibration ON)
4	DTR	Out	RS232
5	TD	Out	RS232
6	PWR	Out	3.3V, max 10mA
7	GND		ref. digital lines
8	DI-1	In	Digital input
9	DI-2	In	Digital input
10	HEAT1	In	Power, mic. heating
11	HEAT0	In	Ref. for HEAT1
12	DSR	In	RS232
13	RD	In	RS232
14	GND		ref. analogue signal
15	AC-out	Out	Analogue output
Housing	GND		Instrument casing

Analogue output

The analogue output is normally a reproduction of the input signal from the microphone obtained by a digital to analogue converter.

Max output voltage: ±10 volt.

Output impedance: < 100 ohm. The output is short-circuit proof to GND and output current is in excess of 10 mA

Gain accuracy at 1 kHz: ±0.4 dB.

Frequency response re. 1 kHz:
±1dB for 20 Hz < f < 16 kHz.

Serial I/O port

RS232 port, 9600 – 115200 baud. The port may be switched off to reduce power consumption, which should be considered if a cable is attached to the socket.

Digital inputs

The digital input signals are 3.3 V CMOS signals. The voltage levels must be within –0.25 V to +5.25 V to avoid harming the instrument.

Input impedance: 10 kohm connected to the positive supply 3.3 volt. Any open input will therefore be in the high state.

Digital outputs

The digital output signals are 3.3 V CMOS signals.

Maximum output impedance: 100 ohm. If not redefined by remote commands, DO-3 will go high when the calibration mode is enabled.

Microphone heating

The microphone preamplifier Nor1206 contains a 225 ohm resistor suitable for heating the microphone/preamplifier. A floating voltage supply in the range 0–12 V may be connected between pin 10 and 11. As the lines will be in direct contact with the signal ground on the preamplifier, utmost care has to be taken for not influencing the measurement of low levels.

Data storage

Measured data is stored in the internal memory of the sound level meter. The memory is of the "flash" type retaining the information without battery supply.

Approximately 5 Mbyte is available for the data storage. This corresponds to one of the following examples:

- More than 10 000 global measurement with all available global functions and distribution when octave and fractional octave analysis is switched off
- More than 2 500 global measurements with all available global functions and distribution when octave and fractional octave analysis is active.
- More than 2 500 000 samples of L(t) when only one function is logged, corresponding to more than 60 hours with a resolution of 0.1 sec.
- More than 90 000 samples of L(t) when all 28 functions are logged in profile, corresponding to 25 hours with a resolution of 1 sec.

Environmental conditions

Reference conditions. The reference conditions for the instrument are as specified by IEC 61672-1
Temperature: 23°C
Humidity: 50% RH
Atmospheric pressure: 101.325 kPa

Environmental condition for operation

Temperature: –10°C to +50°C
Humidity: 5% to 90% RH, dewpoint less than 40°C
Atmospheric pressure: 85 kPa to 108 kPa

Environmental condition for storage

Temperature: –30°C to +60°C
Humidity: 5% to 90% RH, dewpoint less than 40°C
Atmospheric pressure: 50 kPa to 108 kPa

Warm-up time

The warm-up time for the main instrument without preamplifier/microphone is very short and the instrument obtains the final accuracy as soon as the self-test is made. Used with a preamplifier and microphone, this time is prolonged due to the charging of the microphone with the polarisation voltage. Normal sensitivity is reached within one minute. Before a recalibration is attempted, at least three minutes for warm-up is recommended.

Sensitivity for vibration

If the instrument is used under strong vibrational conditions, it is recommended to use an extension cable between the preamplifier and the instrument body. The vibration will mainly affect the microphone, which is most sensitive if the vibration is applied perpendicular to the diaphragm. Typical values are 55 dB to 65 dB for acceleration values of 1 ms-2 perpendicular to the diaphragm.

Sensitivity for magnetic fields

The maximum indication for exposure to magnetic field of 80 A/m and any orientation is typically less than 20 dB.

Size and weight

Depth: 28 mm
Width: 74 mm
Length, excl. microphone/preamplifier: 234 mm
Length, incl. microphone/preamplifier: 365 mm
Weight incl. batteries: 630 g

Information for conformance testing

Reference Sound Pressure Level: 114.0 dB re 20 µPa. The reference frequency is 1000 Hz.

Reference Level Range: The instrument has one level range only.

Microphone Reference Point and Direction: The microphone reference point is the geometric centre of the diaphragm of the microphone. The microphone reference direction is from the microphone and along the axis of rotational symmetry for the microphone and preamplifier.

Battery voltage: The instrument will automatically switch off if the battery or external voltage is too low for operation within the stated specifications. The max. battery voltage for conformance testing is 4 ×1.6 V = 6.4 V.

Electromagnetic Compatibility: When the instrument is tested for conformance to electromagnetic compatibility requirements, the instrument should be in the measurement mode, as this normally will generate the highest levels of emissions. The highest susceptibility is normally observed when the display faces the principal direction of propagation for the electromagnetic field.

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Declaration of Conformity

We, NORSONIC AS, GUNNERSBRÅTAN 2, N-3408 TRANBY, NORWAY, declare under our sole responsibility that the product:

Sound Level Meter / Real Time Analyser Nor118

to which this declaration relates, is in conformity with the following standards or other normative documents:

EMC: EN 50081-1
EN 50082-1
following the provisions of the EMC-DIRECTIVE.

Standards:	IEC 60651 CLASS 1	ANSI S 11 1986 TYPE ID
	IEC 60804 CLASS 1	ANSI S 1.4 1983 TYPE 1
	EN 61260 CLASS 1	ANSI S 1.43 1997 TYPE 1

This product has been manufactured in compliance with the provisions of the relevant internal Norsonic production standards. All our products are tested individually before they leave the factory. Calibrated equipment—traceable to national and international standards—has been used to carry out these tests.

This Declaration of Conformity does not affect our warranty obligations.

Tranby, November 2001

Dagfinn Jahr
Quality Manager

The declaration of conformity is given according to EN 45014 and ISO/IEC GUIDE 22.

Norsonic AS, P.O. Box 24, N-3421 Lierskogen, Norway

Completely Revised, Expanded & Up-to-Date

Your approach to the Nor118 documentation depends on what you want to do and how much you already know. The User Documentation has been designed to help you get more benefits from all the analyser's features in less time than ever before.

Need to start by understanding the ideas behind the analyser's design? Read the Introducing Nor118 section. This section outlines, in just a few pages, all the fundamental features of the analyser.

Need to get knowledge about a certain topic? The manual provides detailed information in extensive articles! Lots of tips and hints included!

Need to know the correct procedure for setting the sound level meter up? The order of appearance of the topics reflects the recommended sequence!

Looking for a certain topic, but don't know where to find it? The extensive index provides the keywords you need!

Book Level

Beginning
- ✓ **Some experience**
- ✓ **Intermediate**
- ✓ **Advanced**

Tutorial
- ✓ **How-to**
- ✓ **Reference**

Norsonic AS supplies a complete range of instrumentation for acoustics – from sound calibrators, microphones & preamplifers; via small handheld sound level meters to advanced, yet portable, real time analysers, but also spectrum shapers, building acoustics analysers and complete community, industry and airport noise monitoring systems. Contact your local representative or the factory for information on our complete range of instrumentation.

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